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ABSTRACT

This report is an evaluation by the Rand Corporation of a project designed to raise reading and arithmetic achievement of disadvantaged junior high school students. The project was prepared by Lockheed Missiles and Space Company for the San Jose Unified School District. Described are both the original R-3 program for a small number of students and the current program for a seventh-grade student in a single junior high school. The basic concepts of the remedial programs were: motivational activities to provide curriculum relevance, intensive involvements to improve teacher-student rapport, reading and arithmetic tailored to individual needs, and parental involvement in their children's school activities. Effectiveness and cost are separately analyzed. During a period of four months the average reading gain of students was five months; arithmetic, three months. Students with the lowest entering scores gained eight months in both subjects. Absences increased, but referrals and suspensions decreased. Costs are summarized by major program components including management, dissemination, inservice-training, mathematics, reading, humanities, field trips, and parental involvement. Finally, a cost-effectiveness model is developed which can be used for assessing the impact of change in resource allocation. (JG)

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PROJECT R-3, SAN JOSE, CALIF: EVALUATION OF RESULTS AND DEVELOPMENT OF A COST MODEL

M. L. Rapp, M. B. Carpenter, S. A. Haggart, S. H. Landa and G. C. Sumner

A Report prepared for

SAN JOSE UNIFIED SCHOOL DISTRICT

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PREFACE

This report, prepared at the request of the San Jose Unified School District, evaluates Project R-3, a demonstration program funded under California Assembly Bill-938 to raise the reading and arithmetic achievement of disadvantaged children. The bill provides special programs for junior high school students. If projects are cost-effective, they will be re-funded for up to three years.

The San Jose Unified School District asked Rand to evaluate the original R-3 program, which operated from February 1967 through June 1969. At that time, outside evaluation was a relatively new concept. Because of Rand's objectivity as a third-party observer, we were able to provide feedback to the Program Director that was instrumental in improving the program.

The current R-3 program continues and expands this program, developed under California Senate Bill-28 for use in the eighth and ninth grades of the San Jose Unified School District. The program, successfully carried out for a small group, now includes the entire seventh grade in one junior high school. The same students will participate in the program during the eighth and ninth grades.

This report describes both the original and current programs and analyzes the data for the first semester of the new program, February through June 1970. The analysis reports on progress over the semester and provides detailed information on which the program director can base decisions for improving the program.

To enable the educational planner to concentrate on the effectiveness of alternatives, and to avoid obscuring information about program cost, effectiveness and cost are handled separately. The analysis of effectiveness serves to highlight the problems associated with quantifying measures of effectiveness when a program has multiple goals and diversified activities. A cost model was developed to allow the decisionmaker to explore the cost consequences of variations in the program as an aid to future planning.

SUMMARY

Funded under California Assembly Bill-938, the current R-3 program is an expansion of a previously successful program to raise reading and arithmetic achievement of disadvantaged junior high school students. The basic concepts remain unchanged: motivational activities to provide curriculum relevance; intensive involvements to improve teacher-student rapport; reading and arithmetic tailored to individual needs; and parental involvement in their children's school activities.

The previous program involved only a small number of students, randomly selected for participation, who were at least one but not more than two years below grade level in reading or arithmetic. New State guidelines stipulate that all students in the school's seventh grade be included in the program and continue in it through the ninth grade.

Program guidelines specified that students be grouped heterogeneously. We developed a procedure for objectively accomplishing this grouping by forming 12 classes of 21 students, each reflecting the same range of achievement. This procedure is designed to be useful to any school district interested in a more rigorous method of forming comparable groups that represent a range of achievement. For the purposes of research and evaluation, one can consider each group as a replication of an experiment and examine the impact of uncontrolled variables on these subgroups of the experimental population.

Students were in the program for four months; during that period, average reading gain was five months, arithmetic, three. Students with the lowest entering scores, however, gained eight months in both subjects in that period. Whereas absences increased during the program, discipline referrals and suspensions decreased. (Since the students had been in the same school the fall semester with no special program, we were able to use them as their own controls.)

Based on our own observation and extensive interviews with program personnel, we make several suggestions for improving the program. These are in the areas of program coordination, student orientation to the program, facilitation of achievement gain, and restructuring of the intensive involvements.

The evaluation of the R-3 program also considers the problem of cost-effectiveness. The program resources required and the achievement resulting from the use of these resources were analyzed to determine which resources contributed to achievement. To help in this determination, a cost model for assessing the impact of change in resource allocation was developed.

Since it is beyond the state of the art to realistically handle cost and effectiveness simultaneously, they are treated separately. The use of a single measure, or cost-effectiveness ratio, usually obscures needed information about the cost of a program as well as its effectiveness. Using the cost model frees the decisionmaker to concentrate his attention on assessing the effectiveness of the program.

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I. INTRODUCTION

THE ORIGINAL R-3 PROGRAM

To better understand the current R-3 program, we present a description of the original program, which lasted from February 1967 through June 1969. Under the provisions of California Senate Bill-28 for demonstration programs to raise reading and mathematics achievement, the San Jose Unified School District (SJUSD) was granted State funding in 1967 to develop such a program. The State guidelines recommended that school districts enlist the cooperation of industry in developing programs and encouraged districts to seek outside evaluations.

Program Components

Four elements were considered essential for improved achievement in the target population: motivation, more specifically defined as showing the relevance of classroom work to "the real world"; good remedial instruction in English and arithmetic; intensive involvements to improve rapport between teachers and students; and parent involvement in their childrens' school activities.

SJUSD engaged Lockheed Missiles and Space Company (LMSC) to prepare motivational activities for use with eighth-grade underachievers, predominantly Mexican-American. SJUSD believed that their teachers could handle the remedial work, but that something more was needed to reach the students. In order to participate in the LMSC activities, the students needed better facility in arithmetic and needed to improve their reading ability. Together with LMSC, the program teachers planned the motivational activities. The program teachers designed the remedial reading and arithmetic programs to prepare the students for the motivational activities. In addition, they used a diagnostic-prescriptive approach to tailor each student's remedial work to his individual needs. All activities were planned around the "World of Work" theme. LMSC's motivational tactic was to simulate in the classroom many of the skills necessary to hold a job in our technological

society. The instructional activities of the R-3 program were scheduled for three consecutive hours daily.

The students took many trips to local industries, where they saw people from their own community at work. They then engaged in classroom activities designed to simulate the job performances observed.

There were two other important aspects to the program. First, on two occasions during the school year, the students were taken for four days to a remote site, where they participated in an intensive, highly structured learning unit, developed around a theme suitable to the locale. One theme developed around a "Land Grant Game," which made use of many mathematical skills involved in surveying and required English skills in writing applications for land grants. The students were housed and fed in dormitories at Pfeiffer Big Sur State Park. Another theme was oceanography. At Asilomar State Park, the students engaged in many of the activities of oceanographers, including measuring the salinity of tide pools and collecting, mounting, and correctly labeling specimens.

These involvements served two basic purposes: They demonstrated to the students that learning could take place in any setting. Furthermore, they helped break down teacher-student barriers traditionally reinforced in the classroom. Teachers that participate in activities with their students, eat three meals a day with them, and share free time with them, develop a different relationship with students than is possible in the formal atmosphere of the classroom. It was hoped that both teachers and students would develop new perceptions of each other that would facilitate the learning process when they returned to the classroom.

Second, the importance of involving parents in their childrens' school experiences was recognized as a key factor in a successful program. Special evenings at the school stimulated parent participation in their children's new learning experiences. They were also invited to accompany their children on the trips.

Two SJUSD teachers were selected for the program, a math and a reading teacher. The 36 students involved were divided into 2 groups of 18. While one group was taught arithmetic, the other was taught

reading. The next hour, the classes were reversed. The third hour, all students participated in the R-3 motivational activities under the direction of both teachers, sometimes assisted by outside consultants.

A second curriculum based on the same concepts was developed the following year by LMSC and SJUSD for the ninth grade. It was centered on the theme "You and Your Government."

Staff

The criterion for the selection of teachers was that they be typical of the average SJUSD reading and math teacher. No special attempt was made to recruit master teachers. From the inception of the program, SJUSD wanted to insure that the program could be replicated on a broader basis. Had they chosen master teachers, there would have been some doubt as to whether the success of the program was due to its nature or to the expertise of highly trained teachers. By their method of teacher selection, the latter possibility was, to a large extent, ruled out.

The program had a full-time director whose main tasks were to (1) initiate and maintain close contact with parents of the participants; (2) take an active role in the planning and evaluation of the curriculum in order to insure a smooth-running program; (3) direct the planning and implementation of the intensive involvements; and (4) coordinate the activities of LMSC, SJUSD, and The Rand Corporation, the outside agency selected by SJUSD to do the evaluation.

Student Selection

In the fall, all eighth-grade students of average ability at Woodrow Wilson Junior High School (WWJHS) were administered the California Achievement Tests (CAT) in reading and arithmetic. Those who scored at least one year, but not more than two years, below grade level on either test were eligible for participation in the program. Since replication was a program objective, it was necessary to choose a random sample of eligible students. To avoid biasing the sample by a consideration of other factors, Rand selected the students using a table of random numbers [1].

At another SJUSD junior high school whose student body resembled that of WWJHS fairly well in terms of socioeconomic level, the CAT was also administered to all average-ability students. Only the principal of the school knew why these students had been selected for testing. At the end of the year, Rand randomly selected a comparison group from among those students who had been pre-tested. We used the same pre-test criteria as for the program students. These students were then administered the CAT post-test. This resulted in a double-blind experimental design because neither the students nor their teachers knew they were used as controls for an experimental program.

Tables 1 and 2 show achievement results in the eighth grade for the 1967-1968 school year. Using analysis of covariance to control for differences in pre-test scores, the gains of the program group for boys and girls in both reading and airthmetic were significantly greater (at or beyond the 0.05 level) than those of the comparison group.

There were measured decreases in student suspensions and referrals as compared to similar students in the same school. Attendance at and attitudes toward school improved, and parental involvement in their children's school career increased.

THE CURRENT R-3 PROGRAM

California Assembly Bill-938 provided funds to continue demonstration programs in arithmetic and reading. In January 1970, several of the original Senate Bill-28 programs, including R-3, were re-funded and some new ones were approved.

Three new State requirements for funding have necessitated some extensive changes in the original R-3 program. First, in consecutive years, the program must be in the seventh, eighth, and ninth grades so that participants will have had a three-year exposure to these demonstration programs. Second, and directly related to the above requirement, all students in the school's grade level must be included in the program. Consequently, all materials and activities must be adaptable to a very wide ability range. Finally, only those programs that are cost-effective will be re-funded. Section VI discusses this topic.

Table 1

AVERAGE READING GRADE EQUIVALENTS FOR
EIGHTH-GRADE PUPILS IN THE R-3 PROGRAM,
FALL 1967 AND SPRING 1968

	Boys		Girls	
	Program	Comparison	Program	Comparison
Pre	6.7	6.6	6.9	6.4
Post	8.4	7.9	8.9	7.5
Gain	1.7	1.3	2.0	1.1

NOTE: N equals 33 for the program group, 40 for the comparison group.

Table 2

AVERAGE ARITHMETIC GRADE EQUIVALENTS FOR
EIGHTH-GRADE PUPILS IN THE R-3 PROGRAM,
FALL 1967 AND SPRING 1968

	Boys		Girls	
	Program	Comparison	Program	Comparison
Pre	6.7	6.5	6.9	6.7
Post	7.9	7.0	8.3	7.5
Gain	1.2	0.5	1.4	0.8

NOTE: N equals 33 for the program group, 40 for the comparison group.

In the current R-3 program, the basic concepts of the original R-3 program remain unchanged: motivational activities to provide curriculum relevance, intensive involvement, reading and math tailored to individual needs, and parental involvement. However, there have been changes in their implementation to conform to the new guidelines.

Although the level of funding was the same as for the demonstration program, the greatly increased number of students required a vastly different allocation of resources. Major changes included (1) reduced expenditure for research and development because the program built on work done by LMSC for the original R-3, and (2) increased expenditure

for teaching staff. In addition, the intensive involvement was held at a camp facility† and much of the "housekeeping" was done by program staff and students. Finally, the number of field trips was reduced from about 20 to 4. The reduction in costs makes replication of the program by other districts more possible.

In order to strengthen the core curriculum, a fourth hour was added to the program--humanities. The entire seventh grade was now in the R-3 program for all academic work. In addition, they had physical education and an elective subject, taught by the regular school staff.

A teaching staff of 12 was necessary to create classes of about 20 students for more individualized instruction. Seven teachers from the regular WWJHS staff indicated a desire to teach in the program. Five other teachers were recruited. Important criteria for the selection of these five were a willingness to participate in an experimental program and a strong background in the teaching of reading. All three math teachers had been at WWJHS and indicated a desire to become part of the R-3 staff.

Twelve instructional aides were hired, one for each teacher. The ability to speak Spanish was listed as a desirable but not mandatory characteristic. Nine of the aides spoke fluent Spanish, a decided asset both in dealing with bilingual students and in communicating with Spanish-speaking parents.

Student Grouping

SJUSD required that project participants be grouped heterogeneously by ability. The CAT in reading and math was administered to all seventh graders in January 1970. It served as the pre-test for the measurement of achievement gain and also as the basis for grouping students. Appendix A discusses how students were chosen in order to meet the heterogeneity requirement. As in the past, The Rand Corporation made the selections in order to insure that no extraneous factors would influence the assignment of students to groups.

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†All districts do not have access to such facilities as Big Sur or Asilomar.

Student Scheduling[†]

The two basic groupings of students in the program are (1) 3 teams of 80 students, taught by 4 program teachers, and (2) within each team, 4 classes of 20 students, with the same combination of teachers.

All students had a three-hour sequence of reading, humanities, and R-3, either in the morning or afternoon. Some had one teacher for all three classes, others had one teacher for R-3 and another for reading and humanities. All 80 students on each team had the same math teacher.

Teachers of the same subject had the same period free. For example, there were no math classes scheduled the second or fifth periods. This enabled teachers to coordinate their planning. By scheduling several sections of a subject for the same period, provision is made for team teaching and for any special student re-grouping the teachers think advantageous for specific activities.

The Evaluation

The evaluation of Project R-3 is designed to serve two purposes. The first is an assessment of what was achieved relative to stated goals. To this end, data on achievement gain in reading and arithmetic are analyzed.[‡] In addition, attendance, referrals to the Vice-Principals, and suspensions are contrasted for the same students prior to and during their participation in the program. The rationale is that improved attitude toward school will be reflected in fewer

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[†]The R-3 program is indebted to Mrs. Dorothy Shaw, the girl's Vice-Principal of WWJHS, for devising a schedule of classes to permit maximum flexibility for both students and teachers.

[‡]The use of gain scores for the measurement of true change is known to be inadequate and misleading. In our report for 1970-1971, regression techniques will be used to achieve a more reliable estimate of gains.

A completely adequate approach would involve a statement of program objectives that is not based on achievement gain. An alternative that avoids the problems of change scores would be a statement of achievement goal. For a more complete discussion of the problem, see Ref. 2.

disciplinary problems and increased attendance. These data are discussed in Sec. II.

The second purpose is to provide data that will be helpful to the Program Director in improving the program. There were many interviews with all program personnel. These were designed to elicit their opinions about the strengths and weaknesses of the program and are presented in Sec. III. Our recommendations for improving the program, based on all available data and on personal observation by the evaluation staff, are presented in Sec. IV.

II. STUDENT DATA ANALYSIS

ACHIEVEMENT GAIN

In analyzing achievement gain, we included in the sample only those students for whom we have both pre- and post-test scores in reading and arithmetic, and who were pre-tested prior to 1 March 1970.

Table 3 accounts for the difference between the number of students entering the program in February (253) and the number of students included in the analytic sample (219).

Table 3

PROGRAM ENROLLMENT AND ANALYTIC SAMPLE

Students enrolled at beginning of program	253
Students leaving program	-24
Students returning	+3
New students, February	+3
New students, post-February	+6
Total students at end of semester	241
Less returnees and post-February new students	-9
Total eligible for analytic sample	232
Students missing post-scores	-12
Student with ambiguous post-score	-1
Total available for analytic sample	219

The differences in pre-test means between those computed on the original sample and those computed on the analytic sample are accounted for by these shifts in the student body. Table 4 presents these data. Although the overall pre-test means were not appreciably affected by the sample attrition, individual classes shifted by as much as six points in raw-score means.

OVERALL ACHIEVEMENT GAIN

Table 5 shows overall achievement gain in reading and arithmetic. The standard scores were computed using [3]:

$$z = 100 + 10 \times \frac{\bar{X}_L - \bar{X}_P}{S_P}$$

Table 4

GROUP MEANS ON PRE-TEST FOR ORIGINAL AND ANALYTIC SAMPLES (RAW SCORES)

Group	Reading		Arithmetic	
	Original	Analytic	Original	Analytic
A-1	55.5	58.2	47.0	48.1
A-2	56.7	62.8	47.8	50.6
A-3	61.4	57.6	48.9	47.9
A-4	55.6	55.0	46.3	46.0
B-1	56.3	56.4	47.3	48.0
B-2	57.4	55.0	47.3	46.8
B-3	58.9	58.6	47.2	47.2
B-4	56.7	57.5	47.8	46.7
C-1	56.3	50.2	44.3	40.6
C-2	59.3	61.2	50.9	53.6
C-3	59.8	59.1	46.3	45.7
C-4	56.5	55.4	46.9	45.6
Overall	57.5	57.2	47.3	47.2

Table 5

OVERALL ACHIEVEMENT GAIN, PROJECT R-3

	Reading			Arithmetic		
	Pre	Post	Gain	Pre	Post	Gain
Raw score	57.2	63.1	5.9	20.9	24.8	3.9
Standard score	92.6	92.8	0.2	91.0	90.4	-0.6[a]
Grade equivalent	6.1	6.6	0.5	6.6	6.9	0.3

[a]Note the negative standard-score gain for arithmetic. The interpretation is that, although there was an absolute gain, it was less than would be expected if the WWJHS seventh grade embodied the same characteristics as the norming population and if the traditional instructional format were used.

where $\bar{X}_L$ is the local raw-score mean, $\bar{X}_p$ is the publisher's mean, and S_p is the publisher's standard deviation. The publisher's mean was interpreted to be the raw scores corresponding to grade placements of 7.5 for the pre-test and 7.9 for the post-test. The CAT Manual did

not provide the standard deviation for the seventh grade; we used the eighth-grade standard deviations, which are probably larger [4].

	Reading		Arithmetic	
	Post	Pre	Post	Pre
Publisher's mean	81.5	76.0	75.5	67.5
Publisher's standard deviation	25.5		22.5	

Before interpreting these gains, note:

1. A four-month period of instruction between pre- and post-tests.
2. Because there was no lead time between funding and implementation, students did not have the advantage of coming into a coordinated, preplanned program. Materials were developed as the semester progressed.
3. Because the results of the diagnostic testing in reading were not available until April 23, students had the benefit of reading programs tailored to their needs for only about half the instructional period.
4. The original R-3 program did not make the kinds of achievement gain in its initial semester that it did during the first full year of operation.

In our opinion, it is too early to judge the program's potential.

Achievement Gain by Septiles

In order to divide the seventh grade into 12 classes, each reflecting heterogeneous grouping by achievement, we ranked students on the basis of their pre-test scores. For both arithmetic and reading, we calculated the achievement gain for each of the seven classifications. Table 6 presents these data. Note that while there is some overlap between the two rankings, the students in any given septile for reading are not necessarily the same students as those in the corresponding arithmetic septile.

Table 6

ACHIEVEMENT GAIN BY SEPTILES IN READING AND ARITHMETIC[a]

Septile	Reading			Arithmetic		
	Pre	Post	Gain	Pre	Post	Gain
1	9.0	9.5	0.5	8.2	8.6	0.4
2	7.2	8.1	0.9	7.2	7.4	0.2
3	6.5	7.1	0.6	6.8	6.9	0.1
4	5.8	6.1	0.3	6.3	6.6	0.3
5	5.2	5.3	0.1	6.0	6.3	0.3
6	4.5	4.9	0.4	5.7	6.2	0.5
7	3.6	4.4	0.8	4.9	5.7	0.8

[a]For ease of interpretation, all gain scores are reported in grade equivalents. All computations are made using individual raw scores; the conversion is made using group mean raw scores.

The patterns of achievement gain are somewhat different for the two subjects. As expected, the greatest gains in arithmetic were made by the students with the lowest entering scores. In reading, this group also made large gains, but they were exceeded by those in the second septile. Table 6 illustrates the tremendous range of achievement in the seventh grade and serves to highlight how information may be lost by reporting only overall achievement gains. Nevertheless, there is no strong evidence that the distribution of gains over the septiles is other than random.

Comparison Groups

No pre-tests were administered to any group of comparable students. A post-test was administered to a group of seventh-grade students in another junior high in the district. A t-test between the means of the program and comparison groups showed no significant difference.[†] This was the only group available for comparison and we do not think it was appropriate because:

[†]WWJHS actually performed better than the comparison group, but the significance level was only 0.3.

1. The other junior high is not a Title I school; WWJHS is.
2. The other school has a much smaller percentage of Mexican-American students (27.4 percent) than does WWJHS (72.8 percent);† thus the assumption that both groups can be regarded as samples from the same population is violated.
3. The students to be post-tested at the other junior high were selected on the basis of their entering sixth-grade reading-achievement scores. Therefore, a test at the end of the seventh grade may be measuring differences in sixth-grade as well as seventh-grade learning experiences.

Achievement by Class

Since all 12 classes were initially very evenly matched on the basis of pre-tests, we were interested in seeing if achievement gain would be comparable from class to class. Therefore, we computed gains-scores by class (Table 7). Since we do not wish to invite comparisons among the program staff, we are presenting no individual data, but are reporting ranges of gain and frequency of classes making each

Table 7

ACHIEVEMENT GAIN BY CLASS IN READING AND ARITHMETIC

Months Gain	Reading: Number of Classes	Arithmetic: Number of Classes
1	0	1
2	4	3
3	1	3
4	1	2
5	2	3
6	3	0
7	1	0

†Racial and ethnic survey of 10 October 1968, SJUSD.

gain. Reading ranged from two to seven months gain, arithmetic from one to five.

It is too early in the program to do more than speculate about the reasons for these apparent differences. Obviously, there are differences among teachers--their personalities, their interactions with different kinds of students, the class atmosphere they create, their ability to implement a new program. Next year, a comparable analysis should be made to further explore why some classes--or teachers--are more successful. If certain characteristics of teachers are more desirable for this kind of program than others, an attempt should be made to describe them. This will not be easy. From casual observation, there seem to be as many differences within the group of teachers who achieved good results as between those groups of teachers who did and did not achieve good results. For the moment, we merely wish to acknowledge that these differences exist.

Morning Versus Afternoon Classes

In our search for systematic differences in the results, we speculated about the possible influence of time of day. We explored three ways of making this comparison:

1. Three of the reading teachers taught one class in the morning and one in the afternoon. Table 8 shows the gains their classes made.

Table 8

READING GAINS BY MORNING OR AFTERNOON CLASSES

Teacher	Morning			Afternoon		
	Pre	Post	Gain	Pre	Post	Gain
G	6.2	6.4	0.2	6.0	6.7	0.7
R	6.3	6.6	0.3	6.4	6.6	0.2
L	6.1	6.6	0.5	6.5	7.1	0.6

The results are too anomalous to comment on at any length.

2. Each of the three math teachers taught two classes in the morning, two in the afternoon. Table 9 presents these gains.

Table 9

ARITHMETIC GAINS BY MORNING OR AFTERNOON CLASSES

	Morning			Afternoon		
Teacher	Pre	Post	Gain	Pre	Post	Gain
T	6.6	6.9	0.3	6.7	7.0	0.3
	6.5	6.6	0.1	6.6	6.9	0.3
X	6.6	6.9	0.3	6.5	7.0	0.5
	6.5	6.9	0.4	6.6	6.7	0.1
E	6.2	6.7	0.5	6.9	7.1	0.2
	6.4	6.6	0.2	6.4	6.9	0.5

These results also shed no light on the problem.

3. The final comparison is between those students who had a three-hour block of R-3, humanities, and reading with one teacher in the morning and those who had this in the afternoon. Six teachers taught the blocks. Table 10 presents these data. No differences can be attributed to time of day.

Table 10

READING GAINS BY THREE-HOUR BLOCK, MORNING OR AFTERNOON

Morning			Afternoon		
Pre	Post	Gain	Pre	Post	Gain
6.2	6.8	0.6	6.0	6.6	0.6
6.1	6.6	0.5	6.0	6.4	0.4
5.6	5.8	0.2	6.1	6.3	0.2

Caveat

We have perhaps strained the limits of these analyses. We wish to reiterate that this was done only to illustrate how we intend to treat the data from a full year's participation in the program. We think that these are the kinds of analyses that provide decisionmakers with useful information on which to base program changes.

Other Data

Since it is generally accepted that regular attendance and few discipline infractions are indicative of a good attitude toward school, we collected data on the students' attendance, referrals, and suspensions.

Because the program students had been at WWJHS the fall semester, we were able to use them as their own controls. We compared their records for the fall and spring semester, i.e., before the program was initiated and during its semester of operation.

Attendance. Absences increased considerably during the second semester. We have no systematic explanation for this. If we exclude the 22 students who accounted for 962 absences, total absences for the second semester decreased slightly. However, because we do not have this kind of detailed breakdown by student for the first semester, we do not feel justified in making the exclusion. Table 11 presents the data on absences for both semesters.

Table 11

COMPARISON OF ATTENDANCE RECORD, FIRST AND SECOND SEMESTERS

	Students in Program			Number of Absences			Days per Semester	Absences per Student-Day[a]		
	Girls	Boys	Total	Girls	Boys	Total		Girls	Boys	Total
Semester										
First	118	139	257	867	1,108	1,975	89	0.083	0.090	0.086
Second	113	131	244	1,344	1,548	2,892	90	0.132	0.131	0.132
Percent of change in attendance								+59	+46	+53

[a]The divisors in these ratios are total potential student days; absences have not been subtracted.

Referrals. The number of referrals for both boys and girls decreased during the second semester. As in past reports, we have our reservations about the reliability of these data. The question always arises as to whether we are objectively assessing student behavior or merely reporting teacher tolerance for deviations from their normal behavior standards. Table 12 shows referrals.

Table 12

COMPARISON OF REFERRAL RECORD, FIRST AND SECOND SEMESTERS

	Students with Referrals		Number of Referrals		Referrals per Student-Day[a]			Referrals per Referred Student			Referred Students/ Total Students		
	Girls	Boys	Girls	Boys	Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	Total
Semester													
First	34	70	163	237	.016	.019	.018	4.8	3.4	3.8	.29	.50	.40
Second	38	59	103	128	.010	.011	.011	2.7	2.2	2.4	.34	.45	.40
Change, %	+12%	-16%	-37%	-46%	-33%	-42%	-39%	-44%	-35%	-37%	+17%	-10%	0

[a]The divisors in these ratios are total potential student days; absences have not been subtracted.

The 3 R-3 math teachers who met each student for 1 hour daily made 37 referrals. Seven R-3 teachers, who met with students from 1 to 3 hours daily, made 45 referrals; 2 R-3 teachers made none. All 12 R-3 instructional aides accounted for 7 referrals. There was a total of 89 referrals from within the program.

Three elective teachers, who met with program students 3 times a week, made 7 referrals; 2 physical education teachers, who met with students daily, made 22; and the music teacher, who saw the students once a week, made 92 referrals. There were 21 other unidentified referrals from outside the program, for a total of 142.

That there were fewer referrals from within the program may reflect reduced class size or perhaps a greater effort on the part of the program teachers to deal with discipline problems without recourse to official sanctions.

Suspensions. During the first semester, nine students were suspended--three girls and six boys. During the second semester, when students were in the R-3 program, there were six suspensions--one girl and five boys. Although this decrease is small, it is a trend in the right direction.

Teacher Impressions of Student Behavior

In an attempt to assess some of the nonquantitative features of the R-3 program, teachers were requested to submit subjective evaluations of student attitude and behavior change. These evaluations were made in early March and in June. Each teacher was asked to report any significant observations about each student. In June, they were additionally asked to indicate any changes in student attitude or behavior that they perceived since the start of the program.

The subjective nature of the evaluations and the great variety of the responses make a meaningful summary difficult. Consequently, we can report only general impressions and illustrative samples.

In reporting their observations, the tendency of most teachers was to formally or informally structure their responses. One teacher systematically reported reading level, attendance, and behavior for each student. The others tended to fall into informal patterns of responding, noting similar types of information for each student. Typically, two, three, or four factors were mentioned by each teacher for each student. These factors often included ability, achievement, behavior, attitude, personality, participation, physical appearance, and attendance. In addition, teachers frequently compared individual students with class norms. In June, teachers also compared terminal characteristics with initial characteristics, or in some instances, characteristics during the previous semester.

With regard to ability, teachers indicated in a variety of terms that the student was above average, average, or below average. The majority of students were reported as being average or above average. A small number were reported as being very bright or very slow. Many of the responses, particularly in June, indicated that several teachers were somewhat surprised at the abilities of their students. Some reported that students were achieving more than test scores indicated they should. Others indicated that deficiencies in basic skills, poor attendance, or low motivation--rather than lack of ability--were the explanations for poor scores, low achievement, and negative attitudes.

Achievement, in terms of test performance or other objective classroom measures, was rarely reported. Most teachers who indicated achievement reported the student was working harder, doing more problems, or completing more assignments. A few exceptions did occur. One reading teacher reported the reading level in March in terms of grade placement. Another teacher reported improvements in oral reading ability. With regard to math, one teacher reported achievement in terms of the student's mastery of addition, subtraction, multiplication, and division skills. The paucity of comments regarding achievement is due largely to the fact that teachers were instructed to direct their attention to behavioral and attitudinal observations.

Behavior and attitude were well covered. Most teachers identified student behavior as cooperative, uncooperative, or variable. Those who were considered cooperative were generally cited as quiet, serious, respectful, helpful, and hard workers. Those categorized as uncooperative were often described as talkative, playful, disrespectful, rude, or hostile. A large number, whose behavior varied, were described as typical teenagers, moody, or emotionally unstable. A frequent observation, particularly for the uncooperative or variable student, was the negative influence of peer pressures. Teachers often reported students as good, hard workers when seated by themselves or when their friends were absent, but talkative and playful when part of a group. There were several instances, however, where heterogeneous grouping was cited as a constructive measure in reducing the negative aspects of peer pressure. Several teachers reported that they had discussed behavior problems individually with students and that these students often voluntarily changed their seats to be nearer good or serious students. In some instances, the heterogeneous grouping was mentioned with regard to social patterns. In a few instances, teachers reported the formation of new friendships and social groups. In one instance, a teacher related how one of his below-average girls changed seats and developed a friendship with a boy who was an above-average student. As the friendship grew, the girl's behavior and performance on assignments greatly improved.

Several teachers also mentioned the effects of heterogeneous grouping on the more capable students. Many indicated that some brighter students were intolerant of the less-capable students and very impatient with them in group activities. This was particularly mentioned by R-3 teachers. Academically, some teachers also indicated that brighter students became bored with assignments while other students were still challenged.

Overall, the majority of teachers reported a general improvement in the behavior of their students. Many reported a reduction in talking, aggression, fooling around, and rudeness toward adults and other students. Teachers often indicated a strong relationship between the change in behavior and a change in attitudes. Many of these teachers felt the changes in attitudes and behavior were attributable to components of the program. The intensive-involvement trip was most frequently cited as the cause of dramatic and positive changes in attitude and behavior. In the March evaluation, L.S. was reported as a "loud-mouth troublemaker...difficult to motivate." In June, however, the same teacher reported that "this semester, especially after the intensive involvement, he has really begun to work....[L.S.] has become one of my best students...tardies and other minor behavior problems have diminished also." Another teacher reported that L.S. had developed a great deal of self-control with peers and the teacher. A third teacher reported he had become "cooperative and reasonably quiet...even pleasant to me."

In another case, teachers reported T.H. initially to be a poor student with little endurance and low achievement. In June, teachers reported "a pleasant change in [T.H.] since the intensive involvement. He [T.H.] is really involved in the class now. He is no longer sullen or hostile. In fact, he comes in the room with a smile and often gets so involved with the game that he works right into his break." His math teacher reported that he had become his "fastest student" and that he did "fantastic amounts of work" and "huge amounts of homework voluntarily." And a third teacher reported that intensive involvement had "turned him on." This student was also reported to have an unsatisfactory home environment and several older brothers and sisters who were drop outs.

Although many of the reports did not indicate such dramatic changes in attitude, a large number indicated positive changes in attitudes toward teachers and peers that seemed to generalize and continue in the classroom. Most teachers reported that changes in attitude and behavior persisted throughout the semester. Only in a few cases was it reported that the effects wore off within two to three weeks. And only in one case did a teacher report that the student reverted to the behavior he had exhibited during the first class session.

Some teachers felt that another influential aspect of the program was the drama unit they developed. A.R., reported as "immature, childish, and playful in class," changed considerably in her reading and humanities class. The teacher stated "what a change in this girl! She has become almost my right hand man when it is necessary to quiet the group so that work can proceed. A drama unit turned her on and she hasn't been turned off since." Another student reported to be motivated by the drama unit had "shown an increase of maturity, less giggling and hair combing in class, and a turning to a more serious nature."

Most of the remarks regarding personality were made in conjunction with observations on attitude or behavior. The teachers generally indicated that students were shy or outgoing, happy or unhappy, trustworthy or unreliable, friendly or hostile. Many students were initially reported as being shy, withdrawn, and unresponsive. Most teachers reported that these students would work quietly and individually, avoid contact with the teacher and the aides, and often avoid contact with groups of their peers. In several instances, R-3 teachers reported that although they remained shy in other situations, these students increasingly participated in R-3 activities.

Although participation might be considered as an aspect of personality and behavior, many teachers reported it as a separate factor. In general, teachers reported the greatest enthusiasm and frequency of participation from their average and above-average students. Many reported significant increases in both participation and eagerness following the intensive involvement. And, as discussed above, reading teachers noted similar changes following a drama unit.

Most remarks dealing with physical appearance were made in conjunction with social or behavioral problems. Of those students reported to have physical handicaps, most were reported to have personal problems and poor relationships with their peers. None of the teachers reported significant changes in attitude or behavior for these students during the course of the program. Various aspects of the program, particularly the group activities, were often reported to aggravate the social problems of these students. Many of these students did not participate in the intensive involvement although the school nurse assured their parents that they were capable of participating. Several teachers indicated that over-protective parents were part of their students' problems.

Attendance was commonly reported. Many teachers indicated the total days absent but did not state reasons for the absences. Others indicated attendance in general terms--good, fair, poor--and offered impressions about the reasons for absenteeism. In general, those teachers commenting on attendance indicated a reduction in the number of absences for students with chronically poor attendance records. Only in a few cases did teachers report severe increases in absenteeism. For these students, teachers reported that they were losing ground and that the cases seemed hopeless. In most of these situations, teachers cited parents as a contributing cause to absenteeism. After home visits or phone calls, teachers felt parents were too indulgent and that they would allow students to stay home for any reason. They also reported that some parents kept students home for housework or babysitting.

Parent Evaluation

Since only about 20 percent of the parents returned the questionnaire, we feel that their opinions may not accurately reflect the majority of parents. Nevertheless, we report the results of those who completed the evaluation:

Forty-two parents thought the project was worthwhile; four did not.

Forty-three parents thought it helped their children; three did not.

When asked to compare R-3 to regular classes, 28 thought it much better, 10 somewhat better, 5 equal, and 2 worse.

Forty-two parents would like their children to be in an eighth-grade R-3 class; four would not.

Thirty-seven would like to see all classes at WWJHS in the project; eight would not.

Of the parents who wrote comments, eight were favorable, two unfavorable, and one was ambivalent.

III. OPINIONS OF PROGRAM PERSONNEL

We conducted several interviews with teachers and program directors during the semester. We wanted to elicit from those persons responsible for implementing the program their opinions as to its strengths and weaknesses so that we could use this information for suggesting improvements. This section presents their reactions to the program.

DO YOU THINK THE PROGRAM HAD DIFFERENT IMPACTS ON FACILITATING ACHIEVEMENT FOR DIFFERENT ABILITY LEVELS?

The R-3 component went over better with the slower students; the brighter students didn't think it was worthwhile for them.

Some of the very slow students were frustrated because they couldn't do the things the more able could.

We need to do more to challenge the brighter students; more thought has to be given to selecting advanced reading materials.

The brighter students want as much individual attention as do the less able.

Our reading program really didn't get properly underway until after the individual diagnostic tests.

There are too many R-3 lessons which depend heavily on the teacher talking and explaining. The students need an opportunity to work by themselves.

WHAT DO YOU SEE AS THE RELATIVE STRENGTHS AND WEAKNESSES OF HETEROGENEOUS GROUPING VERSUS TRACKING?

In R-3 and the humanities, we were able to team the less with the more able.

The less capable at least tried to participate in discussions because they had models in the brighter students.

The slower students have grown immensely in an atmosphere where stupidity and bizarre actions are not tolerated.

Tracking is much easier for the teacher.

Having a wide range of students served as a catalyst to develop a broadly based math curriculum.

It's hard to keep track of where 20 students are working.

The slower students tend to be disruptive after they reach the end of their attention span, but the brighter students "sat on" them.

It provides the mechanism for bringing about individualized instruction because no lesson or exercise is appropriate for the entire group.

WHAT DO YOU THINK THE PROGRAM ACHIEVED IN THE NONCOGNITIVE AREAS?

Since the intensive involvement, the students have been more friendly toward the teachers.

Students have learned a great deal about working together in groups. They are beginning to understand team work.

In math I was able to provide success experiences for the slow learners by giving them work they could do and challenge the brighter students by giving them work they had trouble with.

The program provided many opportunities for oral work.

In the small group, the students got to know each other well enough so that most of them weren't afraid to talk in class.

We removed a lot of frustrations by giving students a chance to talk about how they felt. This, in turn, reduced disciplinary problems because they weren't so up-tight.

THE INTENSIVE INVOLVEMENTS WERE A NEW EXPERIENCE FOR YOU. WHAT IS YOUR REACTION TO THEM?

It was great because we weren't doing the teaching.

It gave us a different role, which helped our image. We didn't have to worry about getting the message across and could be more friendly.

I had to make an effort to involve myself; I felt like a fifth wheel. I was dying to be in the teacher role.

Teachers doing the instruction would be better. When you're teaching, discipline is secondary to the instruction.

We were put in a bad light as observers and watchdogs.

Having teachers and aides do the instruction would keep them in a position where they have to relate to the students at all times.

It was a chance for the students to be with their peers in a new, different and exciting situation.

We really had a chance to sit down and talk to our students.

My worst problem-child has been a changed person since the involvement; he's been like a young adult since our return.

Something happens between students and teachers that really helps teachers. There's a new spirit of cooperation in my room now.

There was a nice blend of cognitive and noncognitive activities. There was enough school work to make the students concentrate; there were enough simple activities to provide success experiences for the slower students.

The involvement humanized the teachers for the students.

It provided excellent opportunity for student interaction in small groups.

It was a pleasant educational experience for the students.

We may have tipped some of the fence-sitters in the right direction.

Students got a much better appreciation of environmental problems by observing, than they could have gotten from reading or lectures.

Those who chose not to go won't miss the next one.

We won't ever be so concerned again about taking our problem students; most of them behaved beautifully.

WHAT DO YOU THINK WAS THE STRONGEST FEATURE OF THE PROGRAM?

The opportunity to work individually with each student.

The freedom from a structured syllabus.

I like the relevance of R-3.

(Everyone) Small classes, aides, intensive involvement.

WHAT DO YOU THINK WAS THE WEAKEST FEATURE OF THE PROGRAM?

The short field trips were generally not well planned.

Three classes in a row in the same room with the same students; it's not good for them or us.

Not enough guidance on how to use an aide.

The diagnostic testing was done too late in the program.

Coordination between the teachers.

The humanities component.

HOW DO YOU THINK THE PROGRAM CONTRIBUTED TO YOUR PROFESSIONAL GROWTH?

I have become a more flexible teacher.

I have learned to go with the students, rather than trying to drag them along with me.

I found that I was a great deal more adaptable than I thought I was.

I've learned a great deal about working with other teachers as a group. I have learned to wait and see what others want to do rather than imposing my own views.

The program has forced me to be specifically analytical of students and their problems. My approach has been more prescriptive than it usually is.

I think the program helped me become a better reading teacher.

I've learned to be more tolerant of other people's problems. I've become more patient.

DID YOUR EXPOSURE TO THE GAMING-SIMULATION (R-3) COMPONENT STIMULATE YOU TO TRY INNOVATIONS ON YOUR OWN?

Yes--it had never occurred to me to play in the classroom before.

Yes--because you can use techniques in small classes that you can't use in a large one.

No--after an hour of R-3, I found them ready for a change of pace.

Yes--we used some games in math and the students responded nicely because they were used to it.

Yes--it got you in the habit of gaming. I put together some phonic games in reading, for example, that I never would have thought of without the program.

* * * * * *

The material cited in this section is illustrative only. It is intended as a demonstration of the kinds of information an evaluation staff can get about a program. The interview information is used to help forestall incipient problems during the course of the program. It is considered during the summer to strengthen the program's next iteration.

IV. EVALUATION FOR PROGRAM IMPROVEMENT

In previous sections, we presented data on achievement gain, attitudinal change, and reactions of program staff to the various components of the program.

Here, we present our recommendations† for changes in the organization and structure of the program. They are based on the analysis of the data, suggestions from the program personnel, and the observations of the evaluation staff.

PROGRAM COORDINATION

In-house communication and coordination of the program components need revision and strengthening. It is in this area that we see the largest qualitative difference between the original, small, R-3 program and the current, expanded version. In the previous program, the Director and the two teachers were in continuous communication with each other and with LMSC for material development.

By expanding from 2 to 12 teachers, a new structure seems to be indicated. Despite 43 meetings of different combinations of staff and directors, at the end of the term some teachers still say they do not understand the R-3 component. The entire staff feels the need for better coordination among the four components so that their classroom activities are focused on the same objectives.

Whereas the solution to the problem needs to come from the program personnel, we would like to present some ideas for their consideration.

* If all program teachers played all the games in the R-3 simulations, they would have an opportunity to analyze the skills involved and plan their classroom activities to build and reinforce these skills.

* The program director could meet with each group of teachers (R-3, math, reading, humanities) once a week to discuss the implementation of a coordinated program. He would act as the synthesizer of information and as a resource teacher to guide these planning activities.

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†These recommendations are marked with an asterisk.

Since the program scheduling allows each teacher three periods a day for planning and preparation, and since all teachers of a given subject are free the same period, this should not pose a scheduling problem.

* Arrangements might be made to have the math teachers lead the gaming-simulation activities for improvement of math skills. This would not only give them a firsthand demonstration of how the R-3 component operates, but it would also give them an opportunity to observe the strengths and weaknesses of their students in handling math concepts in an applied situation.

* The humanities curriculum should be strengthened to reinforce both the reading and R-3 components.

ORIENTING STUDENTS TO R-3

In discussing with teachers how to strengthen the orientation to the seventh-grade program, several suggestions were made that deserve consideration:

* When students enter the program, it should be carefully explained to them. In particular, the role of gaming needs clarification. Many students did not understand that the gaming-simulation is a learning device.

* The fun aspect of R-3 should be de-emphasized in the orientation. Many students expected nothing but good times and it was difficult to change their expectancy.

* The orientation might include some discussion of the use of achievement tests as a tool to diagnose the areas where students need help. This might serve two purposes: remove the element of fear if it exists for any of the students, and elicit their cooperation in doing their best. At the same time, they might be taught the mechanics of test-taking so that their performance is not hampered by a lack of know-how in following directions and marking answer-sheets.

ALLOCATION OF STUDENTS TO CLASSES

In the interests of replication, students were assigned to class groups on the basis of only two criteria: entering achievement scores

to insure heterogeneity within each group, and sex to provide a balance between boys and girls in each group.

During the course of the program, it became apparent that certain combinations of students exerted a disruptive influence on an entire class. If one of the students in the combination was absent, not only did the entire class function more smoothly but the other member of the combination did not cause trouble and seemed to profit from instruction.

* In planning for continuing this program with the same students in the eighth grade, some thought must be given to devising an objective system for breaking up disruptive combinations without destroying the mix of achievement represented in each class. We think this problem should be addressed during the summer months so that the regrouping can be done before school starts.

* Two other aspects of this problem should be considered simultaneously. (1) The desirability of creating entirely new class groups for the eighth grade, taking account of breaking up undesirable combinations. (2) Making a decision as to whether the original pre-test scores or the June 1970 post-test scores should be used in allocating students to classes. We assume that whatever decision is made in this instance would hold for the ninth grade; this should be considered when examining the issue.

FACILITATING ACHIEVEMENT GAIN

Several teachers referred to working with different (generally three) ability groups. We got the definite impression that they were literally tracking within the classroom.

* Since this is not the intent of the program, we suggest that particular attention be paid to working with program teachers to help them plan individual programs for their students. There is certainly no objection to grouping students with the same deficiencies for intensive remedial work--but this grouping should not remain static.

* The objectives of each activity should be explained to the students before it is undertaken; their accomplishment should be discussed after the activity.

* Diagnostic reading tests should be administered during the first two weeks of school.

* Provisions should be made for the brighter students to do some research projects keyed to the R-3 activities. They need an opportunity to work independently.

* Since the top readers do not need a development program, attention should be given to meeting their particular needs. Such areas as building inference-making skills, improving study skills, and in-depth reading in areas of their own interest might provide the basis for strengthening this aspect of the reading program.

IDENTIFYING GIFTED STUDENTS

Two or three teachers mentioned that one of their students should be in a gifted program. * Perhaps R-3 could be used as an identifying program for students who would benefit from SJUSD's gifted program. With small classes and varied activities, teachers see their students in many situations and should be able to make an accurate assessment. It would be a mistake to skim all the top students from the program because they serve as good models for the lower achievers. But the program might provide a good situation in which to identify talented disadvantaged students.

HOME VISITS

* Along with systematic home visits to gain parental support for the program, more emphasis should be placed on seeking parental cooperation in regular school attendance. This may be a sensitive although worthwhile area.

* The few parents who responded negatively to the evaluation questionnaire should be visited by the Program Director.

ROLES OF PROGRAM PERSONNEL

Rather than a teacher and an aide for 20 students, might there be some gains from using a teacher and 2 aides for 30 students? There is no evidence to suggest that reducing class size *per se* contributes

to achievement gain. There is no measure to ascertain whether class reduction is having an effect on achievement in this program. Most often, a teacher uses the same kinds of techniques no matter what the class size; i.e., a teacher who relies heavily on lectures will lecture whether he has 7, 17, or 70 students.

From observation only, we are not convinced that teachers in the program are changing their approach sufficiently to achieve the objectives of the program. If a teacher is working with two instructional aides, his role must change to that of a director of learning activities for his students. His task, in addition to providing instruction, becomes one of coordinating the efforts of the aides.

By scheduling daily meetings with the aides to plan the day's instruction, we see two consequences of possible advantage to the student. First, progress would be systematically checked every day so that no time is wasted on fruitless activities. Second, instruction for each child would have to be individually planned.

We would like to see the program directors give some consideration to the pros and cons of this type of instructional situation. Although it may be neither feasible nor desirable to implement it, discussing its implications may lead to a reconsideration of how the teacher's role might be enhanced.

* There seems to be a need to reassess and possibly redesign the roles of the Director and Assistant Director. We are aware that there was no time for preplanning before the program started and that roles simply evolved. Thus, many of this semester's problems should not recur. Nevertheless, the experiences of the semester should be reviewed because they provide some basis for knowing what to expect. Tasks that needed much attention this year will be performed routinely next year. Some planning for overall program management may contribute to a smoother operation.

Intensive Involvements

* The intensive involvements seem to need restructuring in the area of role definition and allocation of responsibilities. Most

teachers indicated that--despite the fact that they were given an instruction sheet, "Role of Teachers and Aides During Intensive Involvement"--they were uncertain about what was expected of them. Furthermore, they felt that no one person had overall responsibility for the operation. (This probably reflects the fact that Dr. R. G. Pisano, a Consultant from San Jose State College, was responsible for implementing the learning activities he designed, and the R-3 Assistant Director was responsible for recreation and "housekeeping.") It does suggest the need for better communication between directors and teachers so that there is no future confusion.

* There was unanimity on the desirability of having the involvement at the beginning of the program. By choosing a site closer to San Jose, the duration could be cut to two days and two groups a week could go--perhaps one Monday and Tuesday, the other Wednesday and Thursday. In this way, relationships between teachers and students could be established at the very outset of the program.

* Although the teachers were divided in their opinions about doing the instruction on the involvements or having San Jose State College students as instructors, the feasibility of running the involvements without student instructors should be explored. It is necessary to weigh the benefits to be derived from using outside subject-matter experts against those to be derived from using persons adept in human relationships. Since Dr. Pisano was able to train two of the instructional aides to act as group leaders, it seems reasonable to assume that a great program improvement could be realized by having teachers in this role. Besides cutting the cost of the involvement, it would resolve the ambiguity of the teacher's role and insure their interaction with students.

We strongly recommend that this strategy be closely examined from the standpoint of facilitating replication, decreasing cost, and better accomplishing the objectives of the intensive involvements. Although learning is an important factor, it is subordinate to improving teacher-student relationships.

V. ASSESSING PROGRAM EFFECTIVENESS AND COST

RELATIONS OF R-3 PROGRAM EFFECTIVENESS TO PROGRAM CHARACTERISTICS

Effectiveness of the R-3 Program

The R-3 program was designed to bring about several kinds of cognitive learning and other behavioral changes for the participants. In theory, the extent of these changes that can be attributed to the program constitutes the effectiveness of the program. Several points need consideration. First, the program was designed to bring about more than one kind of change. Second, the effectiveness of any program depends in large part upon the intent of its designers and implementers. Third, to make a clear-cut determination of the program's effectiveness requires relatively firm knowledge of what the changes would have been had the program not been carried out.

Program Objectives

The R-3 program for the spring semester of the seventh grade intended to:

1. Attain a growth in reading achievement as measured by the CAT of 1.5 months per month that the program was in operation.
2. Attain a growth in arithmetic achievement as measured by the CAT of 1.5 months per month that the program was in operation.
3. Improve the students' attitudes toward learning and toward the social environment provided by the school [5].

The original goals, to attain growth in achievement in reading and arithmetic of 1.5 months per month of program operation, were predicated on the assumption that the average grade level in both subjects for students entering the second semester of the seventh grade would be 4.5. It was, in fact, 6.1 in reading and 6.6 in arithmetic, as measured by the CAT pre-test. Thus, in terms of the implied effort required, the originally stated objective was applicable only to the lowest septile, as measured by the pre-test in both reading and

arithmetic. As pointed out in Sec. II, the gains in achievement for this septile in both subjects met or exceeded the objective.

R-3 is funded under California Assembly Bill-938, which suggests the following objectives for the program:

1. The attainment of a normal distribution of achievement in reading for students in the seventh, eighth, or ninth grade in the most concentrated areas of poverty.†
2. The attainment of a normal distribution of achievement in arithmetic for the same student population.

Students who are legally eligible for special education programs for the mentally retarded or seriously emotionally disturbed are excepted from the demonstration programs. The students to be included are those

> who are potentially capable of completing a regular high school program, but who, because of educational handicaps, are unlikely to achieve complete success in high school without a compensatory education program.

The implication is that the success of the program should ultimately be contingent upon the success of the students in high school. Yet, school districts

> shall formulate specific performance objectives which pupils should attain by the end of the school year.

Several differences should be noted between the statements of objectives by the designers of the program and by the Assembly Bill that funds it:

1. The program designers list an improved attitude toward school and the social environment at school as major objectives.
2. The Assembly Bill states a concern with long-run effects but asks for specification of performance in terms of short-run objectives.
3. The program designers quantify (for an assumed entering level of achievement) the improvement to be attained in reading and arithmetic.

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†As designated by the State Director of Compensatory Education under provisions of Education Code Section 6482.

Thus, the designers of the R-3 program have specified a richer set of objectives than those of the Assembly Bill. This does not mean that the two sets of objectives are conflicting, however. It has long been accepted that student achievement in part depends upon such psychological and emotional factors as the student's educational motivation. This, in turn, depends upon student achievement. Thus, the objectives are interdependent; strengthening one strengthens the others [6].

Local educational agencies were given a month to submit an application for funds under Assembly Bill-938 [7] and, upon approval of this application, little more than a month to design and implement the program. Since the curriculum designers in industry could not begin work until program approval, the SJUSD had to start curriculum planning on its own in order to assure that the initial units to be used in February would be ready in time. Throughout the semester, curriculum designers raced the clock to supply material to the teachers.

The application, based on the successful R-3 programs for the eighth and ninth grades in preceding years, incorporated the major features of those programs. In particular, the intensive involvements, the field trips to local sites of interest, and the R-3 class based on gaming and simulation were scheduled. A new class in humanities replaced the social studies of the regular seventh-grade program. The purposes of these activities were to reinforce the work in the reading and arithmetic classes and, particularly in the instance of the intensive involvement, to improve the students' attitudes toward school and learning. Thus, the entire curriculum (except for physical education and electives) had to be redesigned into a coordinated whole; objectives for each activity that clearly related to the activities in reading and arithmetic needed to be specified.

It was extremely difficult to carry out this assignment in the time allotted, particularly because 12 teachers were involved whose efforts needed to be coordinated with each other and with those of the curriculum designers. The result was that teachers (and hence students) were frequently unsure of the objectives of an on-going activity, especially in the case of the humanities class and the local field trips. Often, the objectives of the games in the R-3 classes were obscure to teachers as well as students.

Measurement of Attainment of Objectives

Section II discussed both the results of measuring student achievement in reading and arithmetic and the indicators of changes in student attitudes toward learning and the social environment at school. These areas encompass the primary objectives of the program. No further discussion is included except to reiterate that the available measures cannot be used to show the effectiveness of the R-3 program because measures of what the behavioral change in the same areas would have been without the program are not available.

We can only conclude that the short-term effectiveness of the R-3 program for the seventh grade is not fully known. Since the intent of the program is to bring about lasting changes in student behavior, a long-term evaluation has also been designed [8] for use when the data are available.

As stated earlier, there is very little understanding of the relations of the individual components of the R-3 program to its effectiveness in promoting student achievement. Reference 9 states that some individuals associated with the original R-3 program attribute most of its effectiveness to the intensive involvements, others to the gaming/simulation class (usually referred to as R-3 class), and still others to the activities in the reading and arithmetic classes. Because of the resource requirements and costs of the various components, it would be extremely useful to know the contribution of each component when planning for future expansion of the program in the same or similar districts.

References 8 and 9 point out the need for carefully designed and evaluated experiments to address the above questions. Despite the absence of such experiments, an attempt was made to obtain at least qualitative answers by eliciting the opinions of those involved with the just-completed program--program directors, teachers, teacher aides, and students. The remainder of this section discusses the results of this attempt.

Aspects of the Program That May Have Contributed to Its Effectiveness

A program may be looked at in many ways. For the purposes of resource-effectiveness analysis, activities and resources within the program that work together to produce something of use outside the program can be thought of as components. In general, the components and techniques chosen are based on identifiability of objectives and, in some cases, on significance of the quantity of resources consumed. In addition, it is sometimes useful to single out particular techniques even though they do not appear to consume significant resources because they, too, may assist in the attainment of specified goals. These criteria lead to the following list:

- o Reading class;
- o Arithmetic class;
- o Humanities class;
- o Gaming/simulation, or R-3 class;
- o Intensive involvement;
- o Local field trips;
- o Parent participation and home visits;
- o Heterogeneous grouping;
- o In-service training.

Contribution of Components and Techniques to Program Effectiveness

In an attempt to identify which aspects of the R-3 program made the most contribution to program effectiveness, a relatively detailed questionnaire was administered to program directors, teachers, and teacher aides. In addition, a set of simple questions was answered by the students. The questionnaires are reproduced as Appendices B and C.

The major results of the questionnaire answered by the teachers are shown in Tables 13, 14, and 15. These tables present averages of teacher ratings of the contribution of each R-3 component (or technique, in the case of heterogeneous grouping) to the attainment of several objectives for student behavioral change. The behavioral

Table 13

AVERAGES[a] OF RATINGS BY TEACHERS OF GAMING/SIMULATION, READING, AND HUMANITIES

SCHOOL PROGRAM COMPONENTS	LEARNING OBJECTIVES FOR STUDENTS							
	A. Reading Achievement	B. Arithmetic Achievement	C. Attitude Toward School	D. Attitude Toward Adults	E. Attitude Toward Peers	F. Environmental Awareness	G. Teamwork	Row Totals
1. Reading	55	35	10	5	10	10	15	140
2. Arithmetic	5	30	0	0	5	0	0	40
3. Humanities	20	5	15	10	15	15	10	90
4. Gaming/Simulation	5	15	15	5	20	15	20	95
5. Intensive Involvement	5	5	40	50	30	45	40	215
6. Local Field Trips	5	5	5	5	5	15	5	45
7. Home Visits	5	0	10	15	0	0	0	30
8. Parent Participation	0	0	0	5	0	0	0	5
9. Heterogeneous Grouping	0	5	5	5	15	0	10	40
10. In-Service Training	0	0	0	0	0	0	0	0
TOTALS (Percent)	100	100	100	100	100	100	100	

[a]Rounded to nearest 5 points.

Table 14

AVERAGES[a] OF RATINGS BY TEACHERS OF READING AND HUMANITIES

SCHOOL PROGRAM COMPONENTS	LEARNING OBJECTIVES FOR STUDENTS							
	A. Reading Achievement	B. Arithmetic Achievement[b]	C. Attitude Toward School	D. Attitude Toward Adults	E. Attitude Toward Peers	F. Environmental Awareness	G. Teamwork	Row Totals
1. Reading	40		10	15	15	10	15	105
2. Arithmetic	0		5	0	5	5	0	15
3. Humanities	25		10	15	10	15	15	90
4. Gaming/Simulation	5		10	10	15	5	20	65
5. **Intensive Involvement**	10		25	30	30	40	35	170
6. Local Field Trips	5		10	10	15	25	5	70
7. Home Visits	10		15	10	0	0	0	35
8. Parent Participation	0		5	5	0	0	0	10
9. Heterogeneous Grouping	5		10	5	10	0	10	40
10. In-Service Training	0		0	0	0	0	0	0
TOTALS (Percent)	100		100	100	100	100	100	

[a]Rounded to nearest 5 points.

[b]Not rated by these teachers.

Table 15

AVERAGES[a] OF RATINGS BY ARITHMETIC TEACHERS

SCHOOL PROGRAM COMPONENTS	LEARNING OBJECTIVES FOR STUDENTS							
	A. Reading Achievement	B. Arithmetic Achievement	C. Attitude Toward School	D. Attitude Toward Adults	E. Attitude Toward Peers	F. Environmental Awareness	G. Teamwork	Row Totals
1. Reading	20	5	5	5	0	5	0	40
2. Arithmetic	40	60	15	5	0	5	20	145
3. Humanities	5	0	0	5	5	5	5	25
4. Gaming/Simulation	5	5	0	5	5	10	15	45
5. Intensive Involvement	5	15	30	30	25	60	30	195
6. Local Field Trips	5	5	5	5	5	10	5	40
7. Home Visits	10	5	30	25	5	0	0	75
8. Parent Participation	5	0	0	0	0	0	0	5
9. Heterogeneous Grouping	5	5	15	20	55	5	25	130
10. In-Service Training	0	0	0	0	0	0	0	0
TOTALS (Percent)	100	100	100	100	100	100	100	

[a]Rounded to nearest 5 points.

change sought was specified in the questionnaire. Teachers were asked to rate the contributions on a scale of 0 to 100 percent, with the numbers in the column for each objective totaling 100 percent.

Instead of displaying the average responses for all teachers in the program, the averages were computed for three groups of teachers--those who taught two classes of gaming/simulation and one each of reading and humanities (Table 13), those who taught two classes each of reading and humanities (Table 14), and those who taught four classes of arithmetic (Table 15). There were six teachers in the first group and three in each of the other two.

The differences among corresponding cells in the three tables are striking, particularly the cells giving the rating of the contribution of arithmetic to reading achievement (cell A.2). These differences are made even clearer by comparing the row totals, which indicate the relative weight that teachers assigned the contribution of the component to the students' growth as a whole. The differences in the row totals for the first four components suggest that the teacher ratings are strongly biased by the particular program activities in which the raters engaged.

Several other features of these tables should be discussed. Apparently, the teachers were confused by the term in-service training (component 10) because they rated its contribution to program objectives as negligible despite the fact that they regularly met to discuss the program during the school day and attended 43 extracurricular meetings for program planning and evaluation. Since none of these activities was explicitly named in-service training, their low rating may be based on their assumption that they received essentially none.

Probably, the relatively low ratings given home visits and parent participation (components 7 and 8), except for the high rating given home visits by the arithmetic teachers, result from the tendency to think in terms of only the direct contributions made by each component. Nevertheless, this does not explain why columns C and D did not receive higher ratings for these components.

We re-emphasize that many of the objectives of the R-3 program are interdependent. Thus, although the intensive involvement received

consistently low ratings for its contributions to academic achievement, its heavy scores for attitude change suggest that it may have indirectly supported improvements in academic achievement.

Finally, it is not clear why the arithmetic teachers gave so much more credit to heterogeneous grouping than did the others. The high rankings for this technique in column E on Table 15 might be attributable to the requirement for individualized (and hence less competitive) instruction that arose from the heterogeneous grouping in arithmetic. In addition, the arithmetic teachers may have been more heavily involved in the group efforts on the intensive involvements, which may account for the higher weight in column C. Still, this does not explain why the corresponding cells received relatively low weights on Table 13, which reports the responses of the gaming/simulation teachers, who presumably engaged their classes in a large amount of group activity.

Before leaving this discussion of the teachers' responses to the questionnaire, it should be mentioned that these responses were stratified on the basis of criteria other than the subject matter taught. One criterion involved the teachers' prior teaching experience (Appendix B, p. 125); another, his linguistic ability; and the third, a subjective rating of teacher efficacy by the program director. None of these stratifications revealed differences of opinion comparable to those attributable to the subject matter taught.

The rankings of components by teacher aides are not presented because of the evident difficulty the aides experienced in making these assessments.

Nearly 200 students responded to the student questionnaire presented in Appendix C. Table 16 summarizes these responses by presenting the three most popular choices for each of the four questions. The most obvious feature of this table is that the popularity of the intensive involvement swamped other student choices for the first question. Additionally, the humanities class was generally disliked and considered unhelpful in schoolwork. This may have largely resulted from the confusion that apparently existed concerning the objectives of the humanities class. Arithmetic class was generally considered the most helpful activity, possibly because there was little reading

Table 16

SUMMARY OF STUDENT RESPONSES TO QUESTIONNAIRE

Category and Subject	No. of Students Choosing
Most enjoyable	
Intensive involvement	119
Short field trips	30
R-3 class	26
Least enjoyable	
Humanities class	67
Reading class	41
Short field trips	36
(R-3 class)	(15)
Most helpful in school work	
Arithmetic class	90
Reading class	39
R-3 class	38
Least helpful in school work	
Humanities class	72
Reading class	34
R-3 class	31

involved. The indecision on the helpfulness or unhelpfulness of reading class and R-3 class is evident from the nearly even split between the two in responses on the last two questions. To demonstrate that R-3 class was generally enjoyed, the number choosing it as least enjoyable (question 2) is included in parentheses in Table 16.

Table 17 displays all student responses to the questionnaire, stratified by teacher. Each class had either two or three teachers for the program, one for math and one or two for reading, humanities, and R-3 class. The teacher designators shown in the table were chosen at random and are unrelated either to the spelling of the names of the teachers or to the teacher numbers assigned during the program. Only the teacher designators for the reading and arithmetic teachers are shown. For a given teacher combination, the number of responses to each of the four questions is generally different because students may

Table 17

STUDENT RESPONSES BY TEACHER[a]

Category and Subject	Teacher Designators								
	C&X (1)	D&T (2)	F&T (3)	G&T (4)	I&E (5)	L&E (6)	M&E (7)	R&X (8)	Y&X (9)
Most enjoyable									
Reading	0	1	2	1	1	0	1	0	0
Arithmetic	5	0	5	6	1	2	2	2	1
Humanities	0	0	0	1	0	0	0	2	0
R-3 class	2	0	0	4	6	8	0	5	1
Field trips	*7*	2	4	4	4	6	2	0	2
Int. inv.	4	*15*	*10*	*16*	*9*	*17*	*19*	*16*	*11*
Least enjoyable									
Reading	*5*	3	1	13	*4*	5	1	1	*8*
Arithmetic	2	2	2	0	*4*	8	3	*10*	1
Humanities	3	*7*	*11*	*15*	2	*16*	4	5	3
R-3 class	2	2	4	0	1	0	*6*	0	0
Field trips	*5*	4	3	3	*4*	2	4	6	5
Int. inv.	0	0	0	0	1	2	0	0	0
Most helpful in schoolwork									
Reading	4	1	6	2	2	5	*8*	*9*	2
Arithmetic	*8*	*10*	*9*	*21*	*8*	*15*	7	6	*7*
Humanities	3	0	0	3	0	2	2	4	0
R-3 class	5	3	2	4	7	7	3	4	3
Field trips	0	2	2	0	1	4	1	1	0
Int. inv.	0	2	1	3	2	1	1	1	6
Least helpful in schoolwork									
Reading	3	0	1	*10*	4	*9*	3	4	0
Arithmetic	2	0	0	0	4	4	3	4	3
Humanities	*5*	5	*15*	*10*	*6*	*9*	*8*	*7*	*6*
R-3 class	1	3	3	6	2	8	2	3	3
Field trips	3	*9*	0	0	1	4	0	6	3
Int. inv.	*5*	0	1	0	1	3	1	1	0

[a]Italics indicate the most popular response to this question.

have selected no activity or have entered more than one choice in response to a given question.

Despite the fact that the teachers in the program differed widely in their personalities and teaching styles, there is amazing consistency in responses from class to class. Notable exceptions occur,

however. For example, in Table 17, column 1, students preferred field trips to the intensive involvement and split evenly in selecting the humanities class or the intensive involvement as the least helpful in their schoolwork. Personality difficulties between the students and a particular reading and humanities teacher may account for the pattern of responses shown in column 4.

Each class was composed of students drawn from each of the septiles in the pre-test scores on reading and arithmetic, as discussed in Appendix A. Therefore, we categorized student responses on the basis of their pre-test scores. To simplify the presentation, the septiles were grouped into high (septiles 1 and 2), medium (septiles 3, 4, and 5) and low (septiles 6 and 7) for both reading and arithmetic. Nine groups were then formed from the possible combinations of these categories, with Group I indicating high reading and high arithmetic, Group II high reading and medium arithmetic, and so on.

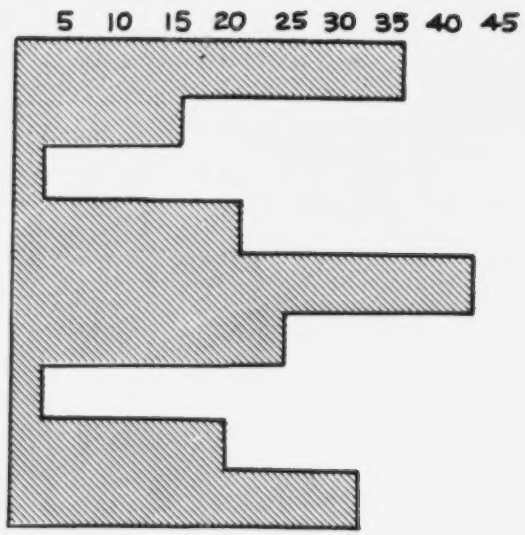
Figure 1 displays the full array of groups and the number of students in each. Because of the small number of students in Groups III and VII, they were dropped from further consideration.

The resulting stratification of student responses is displayed in Table 18. Only the responses that were first and second in popularity for a given group are listed.

Table 18 serves to highlight the impact of the program for different ability levels. For example, it shows that although all achievement groups rated the intensive involvement as most enjoyable, students with high entering achievement in arithmetic (Groups I and IV) listed arithmetic second, whereas students of medium entering achievement in arithmetic (Groups II, V, and VIII) usually gave the R-3 class as second choice. Students of low entering achievement in arithmetic (Groups VI and IX) may have wanted to escape the classroom, which may account for their choice of the field trips as second in popularity to the intensive involvement.

As before, students were fairly consistent in disliking the humanities class, except that students who were high in arithmetic and either high or low in reading (Groups I and VI) disliked the reading class more. Perhaps reading was geared too much for the average

GROUP NO.	NO. STUDENTS	PRE-TEST ACHIEVEMENT SCORES
I	36	High Read/High Arithmetic
II	16	High Read/Med. Arithmetic
III	3	High Read/Low Arithmetic
IV	21	Med. Read/High Arithmetic
V	43	Med. Read/Med. Arithmetic
VI	25	Med. Read/Low Arithmetic
VII	3	Low Read/High Arithmetic
VIII	20	Low Read/Med. Arithmetic
IX	33	Low Read/Low Arithmetic



High = septiles 1 and 2 for either reading or arithmetic.
Medium = septiles 3, 4, and 5 for either reading or arithmetic.
Low = septiles 6 and 7 for either reading or arithmetic.

Fig. 1--Number of Students in Pre-Test Achievement Groups

Table 18

STUDENT RESPONSES BY ACHIEVEMENT GROUP[a]

Category	Achievement Group I	II	IV	V	VI	VIII	IX
Most enjoyable	*Int. inv.*[b] Arith. class	*Int. inv.* R-3 class	*Int. inv.* Arith. class	*Int. inv.* R-3 class	*Int. inv.* Short field trips	*Int. inv.* Arith. class and R-3 class[c]	*Int. inv.* Short field trips
Least enjoyable	*Read. class and human. class* Short field trips	*Human. class* Read. class	*Human. class* Read. class	*Short field trips* Read. class	*Read. class* Arith. class and human. class	*Human. class* Arith. class	*Human. class* Short field trips
Most helpful in school work	*Arith. class* Read. class and R-3 class	*Arith. class* R-3 class	*Arith. class* Read. class	*Arith. class* R-3 class	*Arith. class* Read. class	*Read. class and arith. class* Human. class	*Arith. class* Read. class
Least helpful in school work	*Human. class* Short field trips	*Read. class* Human. class	*Human. class* Short field trips	*Human. class* R-3 class	*Human. class* Read. class	*Human. class* Arith. class	*Human. class* Arith. class and R-3 class

[a]See Definition of groups in Fig. 1, p. 47.

[b]Italics indicate the first choice.

[c]Where two activities appear, the same number of students chose each.

student. Apparently, students of high entering achievement in arithmetic (Groups I and IV) felt the field trips and humanities were a waste of time. Interestingly enough, R-3 class was chosen as the second most helpful activity by the good readers (Groups I and II), but the medium-medium group (Group V) was indecisive about whether or not the R-3 class helped them in their schoolwork.

The contributions of lowered class size and teacher aides to student academic achievement and attainment of other behavioral changes were not included on the teacher questionnaires. It was feared that teachers would consider the contributions of either or both of these program characteristics so important that no information would be gained on the R-3 components themselves. Therefore, the contributions of the teacher aides were sought on a separate page of the questionnaire. Although this procedure can give no indication of the importance of the teacher aides relative to other aspects of the program, it does show which activities of the teacher aides were considered most worthwhile. Table 19 summarizes the responses of the program directors, the teachers, and the teacher aides. Activities are ranked on a scale of 1 to 10, with 1 being the most important and 10 the least important for its contribution to student academic achievement. The teachers and the teacher aides appear to perceive the role of the aides in essentially the same way, but the program directors ranked "make visits to students' homes" and "help students with personal problems outside of class" more highly than either of the other two groups. The program directors also assigned a considerably lower value to the contribution of "correcting papers." All agreed, however, that the most valuable contribution of the aides was in helping students with problems in class.

SUMMARY

The foregoing discussion is intended to demonstrate that the rankings and responses concerning the contributions of R-3 components and techniques to student learning are highly subjective and colored by

Table 19

ACTIVITIES OF TEACHER AIDES RANKED FOR THEIR CONTRIBUTION TO STUDENT ACADEMIC ACHIEVEMENT[a]

Activities	Ranking According To		
	Program Directors	Teachers	Teacher Aides
Assist students with problems in reading or humanities	1	2	2
Assist students with problems in arithmetic	1	4	2
Help students during gaming/ simulation activity	3	4	4
Make visits to students' homes	2	4	6
Correct papers	9	5	6
Handle discipline problems in the classroom	4	5	7
Contact parents concerning student problems	6	7	5
Help students with personal problems outside of class	3	7	7
Assist in general housekeeping in the classroom	9	8	8

[a]Averages of rankings on a scale from 1 (most important) to 10 (least important).

the experiences and perceptions of the respondents. It further illustrates the problems associated with quantifying measures of effectiveness when programs have multiple goals and diversified activities.

ASSESSING THE COST OF THE R-3 PROGRAM

This section provides additional information about the cost of the R-3 program, delineates the rationale for the cost analysis and the methodology for obtaining this information, and describes some of the more important difficulties encountered in the process. The basic intent of the R-3 program under Assembly Bill-938 remains the same as under Senate Bill-28, but the passage of Chapter 1596, Statutes of 1969 (Assembly Bill-938) adds a cost-effectiveness dimension. It was required that an annual assessment be made of the cost-effectiveness of each project, that this cost-effectiveness be adaptable within budgets

of similar school districts throughout the state, and that projects with poor cost-effectiveness be terminated [10].

This was tantamount to opening Pandora's Box and much effort by all districts has been expended in trying to interpret and comply with this requirement. Basically, it would appear that it is a simple task to determine the cost used in the cost-effectiveness analysis and that the more difficult task is to identify the measure of effectiveness. Almost the opposite is true.

The problem is to ascertain the cost of the resources (teachers, equipment, materials, etc.) and the cost of using the resources in specific ways that actually produced a particular effectiveness or achievement. With this logical constraint, it is inappropriate to use the total cost of the program when that total includes, as it does, the cost of disseminating results, or to use the current operating expenses when it excludes, as it might, the cost of some activity that contributes to the achievement.

Another consideration involves the primary intent of the program. If, as should be the case, the intent is to effect a change in the educational process--a change that increases the achievement for the same expenditure of funds, for example--then the relevant cost is the cost to replicate the better educational process in an everyday setting, not a demonstration environment. It is important to remember that the cost to replicate, by itself, does not provide other districts with enough information for their decisionmaking purposes; it is necessary that the specific resources and the quantity and quality of each be known so that the other district can assess the impact of the "new" educational program on their total resources and then translate the resource requirements into a cost to their district [11].

The basic content of the remainder of this section is arranged in the following manner. First, the information provided by the SJUSD under the financial and budgetary requirements of the guidelines for Assembly-Bill-938 programs is displayed in Tables 20 and 21. There is no discussion of the information in these tables. We next describe the procedures used to collect data during the period of the R-3 program. Then, the results of the analysis of these data are presented.

Table 20

R-3 PROJECT--LINE-ITEM INITIAL BUDGET
(Per California School Accounting Manual)

Acc't No.	Category	Total R-3 Project[a]			Research & Development[a]			Current Operating Costs[a]		
		Salaries	Other	Total	Salaries	Other	Total	Salaries	Other	Total
100	Administration									
200	Instruction	$92,855	$134,772	$227,627	$44,161	$116,663	$160,824	$48,694	$18,109	$66,803
300	Attend. service									
400	Health services									
500	Pupil transport.									
600	Ops. of plant									
700	Mtce. of plant									
800	Fixed charges		9,687	9,687		4,490	4,490		5,197	5,197
900	Food service									
1000	Student activities									
1100	Community services									
1200	Capital outlay		28,000	28,000		28,000	28,000			
	Total	$92,855	$172,459	$265,314	$44,161	$149,153	$193,314	$48,694	$23,306	$72,000

[a]An entryless "Contract" column has been omitted.

Table 21

R-3 PROJECT--COST AND BUDGET SUMMARY

	Budgeted	Expended	Balance	Remainder
Pre-operational capital outlay	$ 28,000.00	$ 19,091.45	$+8,908.55	$ 8,908.55
Research and development				
Director	12,684.00	7,846.00	+4,838.00	
Assistant director	11,325.00	7,846.00	+3,479.00	
9th-grade teacher	6,161.00	6,240.00	- -79.00	
9th-grade aide	1,491.00	1,395.00	+ 96.00	
Clerk	4,500.00	2,290.00	+2,210.00	
Technician	5,500.00	4,010.00	+1,490.00	
Hourly salaries	2,500.00	-0-	+2,500.00	
Fixed charges	4,490.00	2,178.93	+2,311.07	
Curriculum development				
Lockheed	75,000.00	75,000.00	-0-	
Consultants	10,000.00	6,800.00	+3,200.00	
Other costs	-0-	5,026.34	-5,026.34	
Evaluation	20,000.00	20,000.00	-0-	
9th grade other costs	1,663.00	796.40	+ 866.60	
Cost-effectiveness analysis	10,000.00	10,000.00	-0-	15,885.33
Current operating costs				
Teachers	30,805.00	31,010.00	- 205.00	
Aides	17,889.00	16,950.50	+ 938.50	
Other costs of instruction	18,109.00	12,617.52[a]	+5,491.48	
Fixed charges	5,197.00	4,111.49	+1,085.51	7,310.49
Total	$265,314.00	$223,209.63	---	$32,104.37

[a] R-3 $ 9,765
Math 1,018
Reading 1,834
$12,617

(This information added by Rand)
Add: Expenses 6-30-70 to 8-31-70 $16,608.34
$15,496.03

The final part covers problems encountered in the process and suggests changes or additional steps that should result in a better future product.

The collection of the financial data required by the guidelines of Assembly Bill-938 was, in part, automated through the data-processing capability of the District. In order to collect the kinds of data needed as a basic input to future cost-effectiveness analysis, it was necessary to set up new and additional procedures.

The budget categories of the California School Accounting Manual are in terms of items of expenditure; it is not possible to use these

categories directly to identify the cost of the desired output (components contributing to program objectives) or to develop the estimates of the cost of possible variations in the R-3 program configuration that might be considered in the future.

In the light of the overall plan to institute changes in the total data-processing capability and information system of the District, it was decided to collect and analyze the resource and cost data of the R-3 program with a minimum disruption of the existing procedures. The program staff collected the budgetary data in the usual manner for the purposes of financial accountability and for program continuation proposals. The program staff also used several forms to collect essentially the same data in a different format. In the design of the forms and during the data collection, Rand staff interacted with the program staff in order to insure reasonable and accurate data and to anticipate and react to potential problem areas. For the most part, this was a successful interaction.

The development and use of a simple resource and cost model of the R-3 program is presented in Sec. VI. This model is intended for use as a tool to explore the consequences of variations in the program. What would be the resource and cost impact of using 1 teacher and 2 aides for a class of 30 students? This type of exploration would provide the information base for future planning.

The data-collection forms used are described and shown in Figs. 2-6; all forms are shown. The purpose is to solicit suggestions for improving the format. The general purpose of the forms is to record the resource requirements and the cost data for each component.

Form A was completed for each component of the R-3 program. These included the reading, mathematics, motivational (R-3), and humanities components of the core instructional program. In addition, Form B was completed for each field trip and Form C was completed for the intensive involvement trips and for the parental participation events. Form D was used to maintain a running log of all requisitioned items. Form E recorded essentially the same data and was used by the individual staff members. These data were then transcribed to Form D.

R-3 PROJECT

SAN JOSE UNIFIED SCHOOL DISTRICT

Component: _____

Description:

Purpose: _____

_____

_____

How accomplished, etc.: _____

_____

_____

_____

Resources Required (total):

Facilities

Furniture

Equipment

Supplies

Staff

Certificated

Classified

Training (specialized)

Cost of Resources:

Fig. 2--Form A: Component Description

R-3 PROJECT

SAN JOSE UNIFIED SCHOOL DISTRICT

Dates: _____

Description:

Purpose:_____

_____

_____

How accomplished (including pre- and post-activities):

_____

_____

_____

_____

Resources Required (total):

Facilities

Supplies

Equipment

Staff

Certificated

Classified

Transportation

Cost of Resources:

Component Relationship (percent):

Reading_____ Mathematics___

Humanities_____ R-3____

Other____

Fig. 3--Form B: Field Trip Data

R-3 PROJECT

SAN JOSE UNIFIED SCHOOL DISTRICT

Dates: _____

Description:

Activity (students and/or parents):) _____

_____

_____

Purpose: _____

_____

_____

Rationale: _____

_____

_____

How Accomplished: _____

_____

_____

Resources Required (total):

Facilities

Equipment

Supplies

Staff

Certificated

Classified

Transportation

Cost of Resources:

Component Relationship (percent):

Reading____ Mathematics____

Humanities____ R-3____

Other____

Fig. 4--Form C: Involvement Data

R-3 PROJECT

SAN JOSE UNIFIED SCHOOL DISTRICT

(Note: Make separate requisition for each budget account)

DATE	REQUISITION NUMBER	ESTIMATED COST	PURCHASE ORDER NO.	ACTUAL COST	ITEM DESCRIPTION

(This form was actually used to collect the Other Costs of Instruction for only the R-3, the Reading and the Mathematics Components. It was also used to collect the expense items for R&D cost and pre-operational cost.)

Fig. 5--Form D: Requisition Log

R-3 PROJECT

SAN JOSE UNIFIED SCHOOL DISTRICT

I. Item Description _____

_____

_____

_____

II. Vendor

Name _____

Address _____

_____

III. Verified Price $_____ Each _____

IV. Number wanted _____

V. Use item will be put to _____

_____

_____

VI. Teacher's Name _____

VII. Component:

Reading _____ %	Mathematics _____ %
Humanities _____ %	R-3 _____ % unit
Other _____ %	

VIII. Activities:

Parent _____ %	Involvement _____ %
Field Trip _____ %	Other _____ %

Requisition # _____

Fig. 6--Form E: Teacher Supplied/Materials Request

The major reason for analyzing the cost of the R-3 program is to provide more and different information than is usually conveyed through the traditional line-item budgetary format. Additional information is necessary in order to avoid gross comparisons among districts. This is especially true when, for example, the total cost of the specific program is divided by the number of students in the program. The resulting cost per student provides a rather shaky basis for any decision about the educational outcome of the program.

We prefer to identify the cost incurred because the program is a research and development program. We then set this cost aside in the evaluation of the outcome achieved through those specific inputs directly related to the educational process. The cost of disseminating information about the research and development program is a good case in point. This cost is relevant for such purposes as assessing the effectiveness of alternative dissemination methods. On the other hand, it is not a relevant cost when determining the cost portion of the cost-effectiveness analysis of alternative educational methods.

The meaning of "more and different" information is shown in Table 22. The cost for each major component of the R-3 program is clearly visible and the component cost is further identified by four general cost categories. From this array, it is easy to gain further insights into the relative expenditures for each component.

Additionally, it is possible to determine the impact on the total program cost of deleting certain components. What would be the cost without the intensive involvement component? What would the cost be without field trips? The answers to these types of questions provide part of the basic information needed for program improvement during the year as well as for planning the next year's program.

Before discussing the details of what is included and excluded in each specific cost category, we provide a brief summary of the assumptions used in the cost analysis. The description of the major R-3 components used as a basis for determining resources requirements and their cost is given in Sec. I.

Most assumptions used in the cost analysis hinge on the fact that the current R-3 program is an expansion of the successful concept

Table 22

COST SUMMARY BY MAJOR COMPONENT OF THE R-3 PROJECT

	R-3 Project[a] Management	Project Dissemi-nation	In-Service Training	R-3	Mathe-matics	Reading	Humani-ties	Field Trips	Int. Inv.	Parental Partici-pation	Total
Facilities and equipment	1,720	400	625	3,500	4,650	3,500	3,500	--	--	--	17,895
Project staff and consultants	119,500	2,800	4,440[b]	12,290	12,290	13,290	12,290	(c)	6,300	(c)	183,200
Support and other	1,150	880	50	750	1,350	950	600	975	7,955	1,835	16,495
Audio-visual	--	2,850[d]	--	710	710	710	710	--	--	--	5,690
Totals	~~112,370~~ 122,370	6,930	5,115	17,250	19,000	18,450	17,100	975	14,255	1,835	223,280

[a]Includes project development and planning, evaluation, etc.

[b]Includes project staff meetings, course planning, and working with Lockheed staff.

[c]Cost of regular staff is not allocated to these components.

[d]Fifty percent of the cost of the audio-visual equipment, materials, supplies, and technician's salary is allocated to Project Dissemination.

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previously used for a smaller group of students. Under the original R-3 program, two classrooms were remodeled and furnished; these classrooms are assumed to be "inherited assets" and the cost of the current program is based on remodeling and furnishing only seven of the required total of nine classrooms.

Much of the audio-visual equipment--specifically, the video-tape recorder--used in the dissemination component and in the classroom instruction is also inherited from the original R-3 program.

Teacher salaries for the total of 12 teachers were distributed in the following way: 7 teachers are paid from the regular district budget and 5 are assumed incremental to the regular school program for the seventh grade and paid for from R-3 program funds. All aides are assumed a part of the R-3 program resource requirements.

In addition, the current R-3 program has included a minimum expense of $7600 for continuing a modicum of the R-3 motivational aspect for present ninth-grade students who were in the program last year.

The cost category "Facilities and Equipment" includes the cost of items identified in the traditional budget as "pre-operational capital outlay"--the cost of remodeling and furnishing the classrooms. It also includes the cost of equipment purchased for continued use in the R-3 program.

The cost category "Project Staff and Consultants" includes the salaries of the R-3 program administrative staff, the teachers, the teacher aides, and the services of all consultants to the R-3 program.

The cost category "Support and Other" includes such items as supplies, materials, special transportation, food and food services, maintenance of equipment, staff travel and supportive expenses, communications, and rental costs for equipment.

The "Audio-visual" (A/V) category, which might be considered a component of the R-3 program, is shown as a cost category in order to make more visible its allocation to the "Project Dissemination" component and to the instructional components. Included in the cost of the A/V category is the cost of the equipment purchased for the current R-3 program, the salary of the A/V technicians, and the supplies and materials used during the program.

In assessing the cost of the R-3 program, several problems were encountered. The source of all problems can be traced to the availability or, more accurately, the unavailability of the necessary data. The solution lies in the development of a workable information system designed to provide, on a timely basis, the kinds of data needed for educational planning--especially when that planning is concerned with evaluation of possible alternatives to existing district programs. As an adjunct to the information system, a resource and cost model should be developed as a supporting tool in educational planning on a district-wide basis as well as for such demonstration programs as the R-3 program.

The SJUSD has taken steps in this direction and we hope that the analyses of the R-3 program can serve both as an impetus and a guide to the development of this capability.

VI. DEVELOPMENT AND USE OF AN EDUCATIONAL-PROGRAM COST MODEL

INTRODUCTION TO THE COST MODEL

The goal of cost-effectiveness analysis is to relate the output (effectiveness) of a program to the inputs (the cost of and constraints on resources) needed to achieve the output. The analysis demands that the decisionmaker have information about (1) the resource requirements of the program, (2) the way these resources are used, and (3) the cost of the resources. This information, coupled with measurements of the effectiveness of the program, provides the basis for cost-effectiveness analysis.

Cost and effectiveness models, computerized or otherwise, can aid the decisionmaker in his analysis. Unfortunately, at this time the development of an effectiveness model is hampered by the impreciseness with which effectiveness can be measured and related to the resources required to produce a specific output [11]. On the other hand, a cost model of an educational program is well within the state of the art. A cost model simply translates the resources required for a particular program into the dollar cost of the program by making use of the interrelationships of the program components, the resources they utilize, and the resource costs. The value of a cost model is that it provides a decisionmaker with the means to rapidly and consistently explore the impact of changes (1) in the costs of resources and (2) in the way resources are distributed. For example, with a cost model, it is possible to assess the consequences on the total budget of a change in teacher salaries or in the student/teacher ratio. In effect, the cost model substitutes for the back-of-the-envelope calculations used by most administrators. As programs grow in scope and complexity, and as districts change to more sophisticated accounting systems, more precise ways of making consistent estimates of educational costs are needed. We propose that a cost model be used so that the decisionmaker can focus on the more difficult and less tractable area of effectiveness analysis.

In order to illustrate the use of the model, we changed the operational configuration of the R-3 program. That is, the cost and quantity of various resources were adjusted to illustrate features of the model. As a result, the output of the model, in terms of resources or costs, does not reflect actual experience in the R-3 program.

THE COST MODEL

Program and Cost Element Structure

To develop a cost model of any program, it is necessary to first define and delimit the program, in this case an educational program within a school. The program components and cost elements considered within the given program are specified:

Subjects
- o Reading
- o Math
- o Humanities
- o R-3

Activities
- o Field trips (FT)
- o Parental Involvement (PI)
- o Intensive Involvement (II)

Just as program components may vary among schools, categorical cost breakdowns may differ among school districts. We selected the following cost structure to present either the costs of the program for a multiyear period or the costs of alternative programs in a given year:

Program Management

Investment
- o Capital costs to add rooms
- o Capital costs to remodel
- o Capital costs to add equipment

Operating Expenses
- o Salaries
- o Materials
- o Equipment maintenance
- o In-service training
- o Food and lodging
- o Transportation

The analysis of a program over time and the comparison of alternative programs within a given period are important aspects of the cost model that contribute to successful planning.

With the program components and cost elements defined, we must then determine the inputs available to the model and the outputs required for analysis and planning.

Model Requirements and Conventions

Input Requirements. The number of possible inputs to the model depends on the level of aggregation of output costs that is satisfactory. The model developed, which required 99 input variables, includes a breakdown of costs by cost element and program component. A way had to be found to display these elements for conceptual ease and quick reference; the user of the model could not be expected to read through a list of 99 variables for every alternative program or year. The solution was to display the inputs in 4 tables, identified as:

Table 1: Inputs Per Subject
Table 2: Inputs Per Activity
Table 3: Inputs Per Teacher
Table 4: Inputs Per Classroom

These tables are displayed with their base-case values in Figs. 7-10.

In explaining the model, we refer to the inputs (and outputs) in the manner used in the actual program. This should enable the reader to more easily examine the computer program. In the program, all the inputs used to calculate costs and resource requirements are stored in an array $w(n,\ell,i)$, where n,ℓ,i relate the values to the input tables in the following manner:

n = input table number
ℓ = row number in the table
i = column number in the table

For example, referring to the input tables displayed in Figs. 7-10:

$w(1,1,1)$ = the number of students enrolled in reading
$w(2,10,1)$ = the average mileage driven (round trip) per field trip

TABLE 1: INPUTS PER SUBJECT

	1. Read	2. Math	3. Hum	4. R-3
1. Enrollment	350	350	350	350
2. Classhrs/wk/stud	10	9	8	3
Class Size				
3. Program	20	20	20	20
4. District	30	30	30	30
Classroom Req.				
5. Regular	0	1	1	0
6. Special	1	0	0	1
Teacher Manhrs/Classhr				
7. Regular	1.00	1.00	1.00	1.00
8. Specialists	.50	.50	.50	.50
9. Aides	.50	.50	.50	.50
10.$Materials/yr/stud	15	10	10	8

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 1
Table Number = 2

Fig. 7--Base-Case Inputs Per Subject

TABLE 2: INPUTS PER ACTIVITY

	1. Field Tr.	2. Inten.Inv.	3. Par.Inv.
1. Number/year	4	2	2
2. Length in days	1.00	4.00	1.00
3. Enrollment	350	350	350
4. Teachers/student	.03	.05	.03
5. No. consultants	0	2	1
6. No. add. participants	0	0	250
7. $Food/person/day	.00	1.00	1.25
8. $Lodge/person/day	.00	.50	.00
9. $/mile/bus	.25	.30	.00
10. Avg. mileage	50	200	0
11. Max bus capacity	60	80	0
Salary/Add.Part./Day			
12. Consultants	50	50	50
13. Bus drivers	35	45	0

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 1
Table Number = 3

Fig. 8--Base-Case Inputs Per Activity

TABLE 3: INPUTS PER TEACHER

	1. Total Manhrs. Avail./Week	2. Ins.Trg. Hrs./Week	3. Annual Salary
1. Regular	30	1	11000
2. Specialist	15	0	7500
3. Aide	15	0	4000

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 1
Table Number = 4

Fig. 9--Base-Case Inputs Per Teacher

TABLE 4: INPUTS PER CLASSROOM

	1. Regular	2. Special
1. Number avail.	11	8
2. No.hours avail/wk	30	30
3. $EquipMt/room/year	100	200
4. Cost/add.room	5000	7000
5. EqCost/add/room	500	1000
6. Cost to remodel	2000	3000

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 5

Fig. 10--Base-Case Inputs Per Classroom

w(3,3,3) = the annual salary per teaching aide
w(4,4,1) = the cost to add a regular room.

Output Requirements. The outputs determined as useful are displayed by the routine in 5 tables:

Table 1: Aggregate Cost Summary
Table 2: Program Component Summary
Table 3: Cost Element Summary
Table 4: Physical Data
Table 5: Cost Element by Program Component Summary (the user may optionally request this table).

Table 1 presents costs in actual dollar amounts computed. Output Tables 2, 3, and 5 present costs in hundreds of dollars. To facilitate comparison of alternative programs or years, the output tables were structured so that in each cost, program, or resource category, the alternatives or years are listed together. Examples of output Tables 1-4 are given in Fig. 11, and the corresponding Table 5 is listed in Fig. 12. This output is the result of increasing the costs of materials to (1) $20 per student per subject (Alternative 1), and (2) $30 per student per subject (Alternative 2). The way in which this variable was altered is explained on p. 91.

In the computer program and the following discussion, the output tables are referred to by the following arrays:

Table 1:	d(N,i)	i=1(1)5
Table 2:	b(N,i)	i=1(1)10
Table 3:	c(N,i)	i=1(1)8
Table 4:	c(N,i)	i=1(1)9
Table 5:	a(N,i,k)	i=1(1)8,b=1(1)6

where N = alternative program or year (N=0(1)7 where N=0=base case/base year).
i = category designated by column heading.
k = cost element (1=salaries, 2=materials, 3=equipment maintenance, 4=in-service training, 5=food and lodging, 6=transportation).

TABLE 1

	Total Cost	Cost/ Student	Inc.Cost/ Student	Program Mgmt.Cost	Additional Capital
Base Case	304843.33	870.98	.00	142000.00	3000.00
Alternative 1	317793.33	907.98	37.00	142000.00	.00
Alternative 2	331793.33	947.98	40.00	142000.00	.00

TABLE 2: COST ELEMENT SUMMARY

	Sal	Matl	Mt. Equ	Ins. Trg.	Fd.+ Lodg	Tran	Tot	Cap Rms	Cap Equ	Cap Rem
Base Case	2736	151	26	66	60	10	3048	0	10	20
Alternative 1	2736	280	26	66	60	10	3178	0	0	0
Alternative 2	2736	420	26	66	60	10	3318	0	0	0

TABLE 3: PROGRAM COMPONENT SUMMARY

	Read	Math	Hum	P-3	FT	II	PI	Tot
Base Case	987	870	777	308	13	77	16	3048
Alternative 1	1004	905	812	350	13	77	16	3178
Alternative 2	1039	940	847	385	13	77	16	3318

TABLE 4: PHYSICAL DATA

	Teachers			Classrooms					
	Reg	Spec	Aide	No.Req.		No.Rem.		No.Add.	
				Reg	Spec	Reg	Spec	Reg	Spec
Base Case	18	17	17	10	8	1	0	0	0
Alternative 1	18	17	17	10	8	0	0	0	0
Alternative 2	18	17	17	10	8	0	0	0	0

Do you want a summary of the costs of alternative programs by program component and cost element? Yes=1, No=2. = 1

Fig. 11--Output Tables 1-4 Resulting From an Increase in the Cost of Materials

TABLE 5: COST ELEMENT, PROGRAM COMPONENT SUMMARY

	Read	Math	Hum	R-3	FT	II	PI	Tot
*SALARIES								
Base Case	900	810	720	270	10	26	1	2736
Alternative 1	900	810	720	270	10	26	1	2736
Alternative 2	900	810	720	270	10	26	1	2736
*MATERIALS								
Base Case	53	35	35	28	0	0	0	151
Alternative 1	70	70	70	70	0	0	0	280
Alternative 2	105	105	105	105	0	0	0	420
*EQUIPMENT MT.								
Base Case	12	5	5	4	0	0	0	26
Alternative 1	12	5	5	4	0	0	0	26
Alternative 2	12	5	5	4	0	0	0	26
*INSERVICE TRG.								
Base Case	22	20	18	7	0	0	0	66
Alternative 1	22	20	18	7	0	0	0	66
Alternative 2	22	20	18	7	0	0	0	66
*FOOD + LODGING								
Base Case	0	0	0	0	0	45	15	60
Alternative 1	0	0	0	0	0	45	15	60
Alternative 2	0	0	0	0	0	45	15	60
*TRANSPORTATION								
Base Case	0	0	0	0	4	6	0	10
Alternative 1	0	0	0	0	4	6	0	10
Alternative 2	0	0	0	0	4	6	0	10

Action(Display=1,Change=2,Output=3,Alternative=4,Quit=5) = 5

Fig. 12--Output Table 5 Resulting From an Increase in the Cost of Materials

For example,

a(2,3,2) = the annual material costs for the humanities program, alternative/year 2.

b(0,6) = the total transportation costs for the base case.

c(1,5) = the total cost of field trips for the first year/ alternative.

d(0,4) = the additional capital required for the base-case program.

e(5,3) = the number of teaching aides required for alternative/ year 5.

Note that although a different set of inputs is required for each alternative program or year, it is not necessary to add the dimension N to the input arrays because only the most recent values in the input arrays need be known. Thus, N appears only in reference to output tables.

Additional Conventions. In discussing each major cost category, the following conventions are observed:

kk = total number of subjects in the program

nn = total number of activities in the program

mm = total number of teacher types.

In the computer program, some arrays contain different values at different points in the program. This is done when a set of values need no longer be saved. In the following discussion, an apostrophe appears after a variable name when this name represents a different set of values than previously assigned to it.

Cost-Estimating Methods

Research and Development. An indirect cost of a specific school program includes costs for consultants and research personnel on the staff of the school district who develop the curriculum, methods of instruction, teaching aids, and testing materials for the program. In addition, participating teachers frequently contribute time to program development--thus taking time away from instruction. Although these

indirect costs should be recognized by the administrator, we have not incorporated them into our model, which deals only with direct costs.

Program Management. At this time, this cost is handled as a throughput in the model. It should realistically vary with the size and complexity of the school program, but this will have to be treated by a larger model. Thus, we set:

$$d(N,4) = \$142,000.$$

Investment. In this model, the components of investment costs considered are the capital costs to remodel and/or construct additional classrooms required and the costs to equip these incremental rooms.

Classroom Remodelling and Construction. In order to determine the number of classrooms required, from which we can compute investment costs, we must first calculate the number of classes to be held in each subject. If the nominal number of students in a class for the *ith* subject is given by w(1,3,i), then the number of classes that must be held in each year or program is

$$p(i) = w(1,1,i)/w(1,3,i)$$

where p(i) = number of classes in the *ith* subject;
w(1,1,i) = number of students in the *ith* subject;
w(1,3,i) = nominal number of students per class in the *ith* subject.

It may happen that w(1,3,i) does not divide w(1,1,i) evenly to give an integer number of classes. Since we only deal with whole classes, we must set p(i) equal to the integer part and then decide whether to put the remaining students into the p(i) classes or to increase the number of classes. In order to make this decision properly, we must decide on the maximum number of students we will allow in a class or that the district permits in a class. Then, when the remaining number of students are assigned to the p(i) classes, we are in a position to decide on adding another class. If we were to assign all students to the p(i) classes, the number in each class would be given by Y:

$$Y = w(1,1,i)/p(i)$$

where Y = class size if all students are allocated to p(i) classes. Then, if Y is greater than w(1,4,i), the maximum or district class size, we must add a class. If Y is less than w(1,4,i), only p(i) classes are needed. In mathematical terms, we redefine p(i) as:

$$p(i) = \begin{cases} ip[w(1,1,i)/w(1,3,i) + 1] & \text{if } Y > w(1,4,i) \\ ip[w(1,1,i)/w(1,3,i) & \text{if } Y \leq w(1,4,i) \end{cases}^{\dagger}$$

To determine the number of classrooms needed from the number of classes computed, we must know the number of hours that a class in the *ith* subject meets per week. We can then calculate the total number of class hours per week per subject:

$$h(i) = p(i) \cdot w(1,2,i)$$

where w(1,2,i) = class hours per week per subject i.

Since different subjects may require the use of different types of classrooms, the total number of classroom hours must be divided among the types of classrooms required. In our example, we consider two types of classrooms, regular and special. A special classroom is defined as one that contains equipment needed for a specific subject. Thus:

$$r(i) = h(i) \cdot w(1,5,i)$$

$$s(i) = h(i) \cdot w(1,6,i)$$

where r(i) = regular classroom hours per week per subject i;
s(i) = special classroom hours per week per subject i;

---

†ip = integer part; e.g., ip (37.6) = 37.
fp = fractional part; e.g., fp(37.6) = 0.6.

w(1,5,i) = the proportion of time spent in a regular classroom for subject i;

w(1,6,i) = the proportion of time spent in a special classroom for subject i.

We must now sum the demand over all subjects to determine the total classroom hours required:

$$Z(1) = \sum_{i=1}^{kk} r(i)$$

$$Z(2) = \sum_{i=1}^{kk} s(i)$$

where kk is the total number of subjects taught.

Finally, to compute the demand for regular and special classrooms, we must specify the number of hours per week that each type of room is available for instructional purposes. Let us define w(4,2,1) and w(4,2,2) to be the number of hours that a regular classroom and a special classroom, respectively, are available. Then, we may express the demand as:

$$Z(3) = Z(1)/w(4,2,1)$$

$$Z(4) = Z(2)/w(4,2,2)$$

As with the number of classes, the number of classrooms must be integer. Therefore, if their fractional parts are positive, Z(3) and Z(4) are rounded up. That is,

$$Z(3) = ip(Z(3)) + 1 \text{ if } fp(Z(3)) > 0.$$

$$Z(4) = ip(Z(4)) + 1 \text{ if } fp(Z(4)) > 0.$$

Now we may post the number of regular and special classrooms required to the appropriate output table:

$$e(N,4) = Z(3)$$

$$e(N,5) = Z(4)$$

where e(N,4) = number of regular classrooms required in year/program N.
e(N,5) = number of special classrooms required in year/program N.

In planning for a new school, the cost of Z(3) + Z(4) classrooms would be of interest. However, in planning for a new program within a school, we are only concerned with the number of rooms demanded that exceed the number available. Of course, it is possible that sufficient classroom space already exists--thus requiring no additional investment in construction or remodeling. This would be the case if

$$Z(3) \leq w(4,1,1)$$

and

$$Z(4) \leq w(4,1,2)$$

where w(4,1,1) = the number of regular classrooms available;
w(4,1,2) = the number of special classrooms available.
If, on the other hand, the above constraints are not satisfied, the demand for incremental classroom space is calculated as follows:

$$V(1) = \text{Max}[Z(3) - w(4,1,1),0]$$

$$V(2) = \text{Max}[Z(4) - w(4,1,2),0]$$

It may happen that we have an excess of one type of room and a deficit of the other. In this case, we can remodel the surplus room(s) to partially or fully eliminate the deficit of the other type of classroom. Although the mathematical logic that determines the proper investment policy is quite involved, it is conceptually simple (see

Appendix E). The resulting numbers of classrooms to remodel and to construct are stored in the output tables as e(N,6), e(N,7), e(N,8), and e(N,9). The capital costs are then computed as:

$$b(N,8) = e(N,8) \cdot w(4,4,1) + e(N,9) \cdot w(4,4,2)$$

$$b(N,10) = e(N,6) \cdot w(4,6,1) + e(N,7) \cdot w(4,6,2)$$

where e(N,6) = number of regular classrooms necessary to remodel in year/program N.

e(N,7) = number of special classrooms necessary to remodel in year/program N.

e(N,8) = number of regular classrooms necessary to construct in year/program N.

e(N,9) = number of special classrooms necessary to construct in year/program N.

w(4,4,1) = cost to add a regular room;

w(4,4,2) = cost to add a special room;

w(4,6,1) = cost to remodel a regular room;

w(4,6,2) = cost to remodel a special room.

Recall that w(4,1,1) and w(4,1,2) contain the current number of regular and special classrooms available. Therefore, if we have remodeled or constructed classrooms, we must update these variables accordingly. Thus, we redefine

$$w(4,1,1) = w(4,1,1) - e(N,6) + e(N,7) + e(N,8)$$

$$w(4,1,2) = w(4,1,2) - e(N,7) + e(N,6) + e(N,9).$$

The updated number of regular classrooms, for example, equals the previous number available, minus the number remodeled to special classrooms, plus the number of special rooms remodeled to regular, plus the number of regular rooms constructed. If we are analyzing a program over time, the updated variables must be used to give accurate capital-cost requirements. However, if we are comparing alternative programs,

we have the option of determining the additional classrooms needed compared to the number in existence for the base case or for the previous alternative program represented by w(4,1,1) and w(4,1,2).

Classroom Equipment. Once the number of required incremental classrooms has been determined, the cost to equip these rooms may easily be calculated. This cost is found by multiplying the number of new classrooms of each type by the cost to equip each classroom type:

$$b(N,9) = V(1) \cdot w(4,5,1) + V(2) \cdot w(4,5,2)$$

where V(1) = the number of new regular rooms;
V(2) = the number of new special rooms;
w(4,5,1) = the cost to add equipment to a regular room;
w(4,5,2) = the cost to add equipment to a special room.

Total Investment Cost. The total capital cost incurred in year N or in program N is the sum of its components--classroom remodeling, construction, and equipment costs:

$$d(N,5) = b(N,8) + b(N,9) + b(N,10).$$

Operating Costs. The largest portion of the school budget is allocated to operating costs. The operating budget includes salary costs for teachers, aides, bus drivers, and consultants; transportation costs; material costs, etc. In this model, we present only those operating costs directly associated with the instructional program.

Salaries. This cost category includes salaries for teachers, consultants, and bus drivers directly involved in conducting classes and activities. It does not include the salary cost of teachers for time spent in in-service training, a cost category considered separately. Also, since we are concerned with incremental costs, only the additional number of regular teachers required by the demonstration program is considered. For example, if the district would have supplied 10

teachers for 300 students under the standard program but the demonstration program calls for 15, only the salary cost of the additional 5 teachers is considered. Specialists and teaching aides are not part of the standard program; their salary costs are included in total.

To determine the number of additional regular teachers required by the demonstration program, we must first establish the demand for regular teachers under the standard program. We begin by computing the number of classes required under a standard or district-directed program. Assume that the district-required number of students in a class for the *ith* subject is given by w(1,4,i). Then, the number of classes in subject i that must be held in a standard program with an enrollment per subject w(1,1,i) is:

$$R(i) = \begin{cases} ip[w(1,1,i)/w(1,4,i)] \text{ if } fp[w(1,1,i)/w(1,4,i)] = 0 \\ ip[w(1,1,i)/w(1,4,i)] + 1 \text{ if } fp[w(1,1,i)/w(1,4,i)] \neq 0 \end{cases}$$

Note that R(i) may not be an integer, in which case the model rounds up to the next whole number. The reason for this is that the district-directed number of students per class is assumed to be the upper bound and therefore cannot be exceeded. The total number of class hours per week for the *ith* subject in a standard program may then be calculated from the number of classes required:

$$G(i) = w(1,2,i) \cdot R(i)$$

where w(1,2,i) = class hours per week per subject i.

Recall that the total number of class hours per week by subject for the demonstration program (h(i)) was calculated on p. 74. Thus, having determined the number of class hours necessary under both the demonstration and standard programs (h(i) and G(i)), we need only know the ratio of the number of instructional hours for each type of personnel to generate the number of instructional-personnel hours. Let us define the variables:

$w(1,7,i)$ = regular teacher man-hours per class hour;

$w(1,8,i)$ = specialist teacher man-hours per class hour;

$w(1,9,i)$ = teaching aide man-hours per class hour.

The number of hours per week per subject required of each type of personnel under the demonstration and standard programs would be:

$v(i,\ell) = h(i) \cdot w(1,\ell+6,i)$ demonstration program;

$s(i,\ell) = G(i) \cdot w(1,\ell+6,i)$ standard program;

where ℓ = teacher type, 1 = regular, 2 = specialist, and 3 = aide. Next, it is necessary to total the hours by teacher type. Thus:

$$M(\ell) = \sum_{i=1}^{kk} v(i,\ell)$$ for the demonstration program.

$$O(\ell) = \sum_{i=1}^{kk} s(i,\ell)$$ for the standard program.

When these totals are divided by the number of hours each type of personnel is available per week, we have an estimate of the number of personnel required to teach the subjects:

$T(\ell) = M(\ell)/[w(3,\ell,1) - w(3,\ell,2)]$ demonstration program;

$R'(\ell) = O(\ell)/w(3,\ell,1)$ standard program;

where $w(3,\ell,1)$ = total man-hours available per week per teacher type ℓ

$w(3,\ell,2)$ = hours spent per week in in-service training per teacher type ℓ.

Note that in calculating the teacher requirements for the regular program, the number of hours each type spends in in-service training is not a factor. If, in some programs, specialists and aides do not participate in in-service training, $w(3,2,2)$ and $w(3,3,2)$ would both equal

zero. Note too that $T(\ell)$ and $R'(\ell)$ must equal integers since the number of teachers cannot be fractional. Hence, if either has fractional parts, the model rounds up to the next whole number:

$$T(\ell) = ip(T(\ell)) + 1 \text{ if } fp(T(\ell) > 0$$

$$R'(\ell) = ip(R'(\ell)) + 1 \text{ if } fp(R'(\ell)) > 0$$

Finally, we can set:

$$e(N,\ell) = T(\ell), \ \ell = 1,2,3.$$

At this point, we have completed output Table 4 on physical data requirements.

Given the average salary in each of the personnel categories, we may now estimate the cost of personnel for teaching. First, let

$$A(\ell) = (w(3,\ell,1) - w(3,\ell,2))/w(3,\ell,1).$$

This equation computes the fraction of the teacher's total work week spent in instruction, in-service training time being subtracted (accounted for in a separate category). Then,

$$a(N,i,1) = \sum_{\ell=1}^{mm} A(\ell) \cdot \underbrace{[(v(i,\ell) \cdot w(3,\ell,3)/M(\ell)]}_{(1)} \cdot [T(\ell) - R'(\ell)]$$

where mm = number of teacher types. The expression identified as (1) computes the proportion of total salary costs to allocate to each subject area.

We must also compute the salary costs per activity, $a(N,kk+1,1)$, $i = 1,2,3$, i = type of activity, kk = number of subjects, for bus drivers and consultants. To determine the number of bus drivers required per activity, we must compute the number of buses necessary. This involves calculating the number of participants per event for each activity. Let

$$g(i) = w(2,3,i) \cdot w(2,4,i)$$

where g(i) = number of teachers required per activity;
w(2,3,i) = enrollment per activity i;
w(2,4,i) = teacher/student ratio per activity i;
and,

$$f(i) = [w(2,3,i) + g(i) + w(2,5,i) + w(2,6,i)]/w(2,11,i)$$

where f(i) = number of buses/bus drivers required by activity i;
w(2,5,i) = number of consultants per activity i;
w(2,6,i) = number of additional participants per activity i.
w(2,11,i) = maximum bus capacity per activity.
Both g(i) and f(i) are rounded up to integers if necessary. The salary costs per activity for bus drivers and consultants are:

$$a(N,kk+i,1) = f(i) \cdot w(2,13,i) \cdot w(2,2,i) \cdot w(2,1,i)$$

$$+ w(2,5,i) \cdot w(2,12,i) \cdot w(2,1,i) \cdot w(2,2,i)$$

where w(2,13,i) = salary costs for bus drivers per day per activity i;
w(2,2,i) = length in days of each event per activity;
w(2,1,i) = number of events per year per activity;
w(2,12,i) = salary costs for consultants per day per activity i.
Finally, the total salary expense for the demonstration program is computed by summing the salary costs over *all* subjects and activities.

$$b(N,1) = \sum_{i=1}^{kk+nn} a(N,i,1).$$

In-service Training. These costs may be determined in the same manner as teacher salary costs. Let

$$A'(\ell) = w(3,\ell,2)/w(3,\ell,1).$$

This is the proportion of the work week spent in in-service training. Then,

$$a(N,i,4) = \sum_{\ell=1}^{mm} A'(\ell) \cdot [v(i,\ell) \cdot w(3,\ell,3)/M(\ell)] \cdot T(\ell).$$

Recall that

$v(i,\ell)$ = number of hours required per week per subject per teacher type ℓ;
$w(3,\ell,3)$ = salary costs per teacher type;
$M(\ell)$ = total hours required per week per teacher type ℓ;
$T(\ell)$ = number of teachers of type ℓ required.

The total cost for in-service training equals:

$$b(N,4) = \sum_{i=1}^{kk} a(N,i,4).$$

Materials. These costs include supplies and books required for each student for each subject:

$$a(N,i,2) = w(1,10,i) \cdot w(1,1,i)$$

where $w(1,10,i)$ = material cost per student per year for the *ith* subject;
$w(1,1,i)$ = enrollment per year for the *ith* subject.

The total cost of materials for the program is:

$$b(N,2) = \sum_{i=1}^{kk} a(N,i,2).$$

Equipment and Maintenance. This operating cost category includes the cost of maintaining equipment in both the regular and special classrooms:

$$a(N,1,3) = [r(i)/Z(1)] \cdot Z(3) \cdot w(4,3,1)$$

$$+[s(i)/Z(2)] \cdot Z(4) \cdot w(4,3,2)$$

where r(i) = number of regular classroom hours required per week for the *ith* subject;
Z(1) = total number of regular classroom hours required per week;
Z(3) = number of regular classrooms required;
w(4,3,1) = equipment maintenance costs per regular room per year;
s(i) = number of special classroom hours required per week for the *ith* subject;
Z(2) = total number of special classroom hours required per week;
Z(4) = number of special classrooms required;
w(4,3,2) = equipment maintenance costs per special room per year.

Total equipment maintenance costs equal:

$$b(N,3) = \sum_{i=1}^{kk} a(N,i,3) \ .$$

Food and Lodging. In the model, such activities outside the classroom as field trips, intensive involvements (overnight field trips), and parental involvements (e.g., dinners) are considered. These activities may incur direct costs for food and lodging of the participants.

$$a(N,kk+i,5) = [w(2,3,i) + g(i) + f(i) + w(2,5,i) + w(2,6,i)]$$

$$\cdot [w(2,7,i) + w(2,8,i)] \cdot [w(2,2,i) \cdot w(2,1,i)]$$

where w(2,3,i) = enrollment per activity i;
g(i) = number of teachers per activity i;
f(i) = number of bus drivers per activity;
w(2,5,i) = number of consultants per activity;
w(2,6,i) = number of additional participants per activity i;
w(2,7,i) = food cost per person per day for activity i;
w(2,8,i) = lodging cost per person per day for activity i;
w(2,2,i) = length in days of each event per activity i;
w(2,1,i) = number of events per year per activity i.

Total food and lodging costs are:

$$b(N,5) = \sum_{i=1}^{nn} a(N,kk+i,5).$$

Transportation. Transportation costs are affected by such factors as mileage per trip, number of trips, and number of participants. One factor not incorporated into the preliminary model is that these costs also depend on whether school-district buses are used or whether buses are rented. A complete model must take this point into consideration. Transportation costs are computed here as:

$$a(N,kk+i,6) = f(i) \cdot w(2,1,i) \cdot w(2,10,i) \cdot w(2,9,i)$$

where f(i) = number of buses for each event per activity i;
w(2,1,i) = number of events per year per activity i;
w(2,10,i) = average mileage per event per activity i;
w(2,9,i) = cost per mile per event per activity i.

Total transportation costs are:

$$b(N,6) = \sum_{i=1}^{nn} a(N,kk+i,6)$$

Costs by Program Components. We are now in a position to allocate costs by program components (output Table 3), having completed the array a(N,i,k):

$$c(N,i) = \sum_{k=1}^{6} a(N,i,k) \ .$$

That is, we are summing over all cost categories (6) by subject and activity.

Aggregate Costs. *Annual Operating Costs.* We may now write an expression for the annual operating costs (d(N,1)) of the program/year under consideration:

$$d(N,1) = b(N,7) = c(N,8) = \sum_{i=1}^{6} b(N,i) = \sum_{i=1}^{7} c(N,i) \ .$$

Per Student Costs. Since program management costs and total capital costs have already been posted to output Table 1 (see pp. 73 and 78), Table 1 is complete at this point except for the cost per student and the incremental cost per student. The former is computed as:

$$d(N,2) = d(N,1)/\max(w(1,1,i)) \ .$$

Because the number enrolled in each subject and each activity may vary, the largest number enrolled in any one program component was arbitrarily selected as representing the number enrolled in the demonstration program. Thus, the cost per student is a very rough measure and should be weighted in accordance. Incremental costs between years or alternative programs would be:

$$d(N,3) = d(N,2) - d(N-1,2) \ .$$

Total System Cost. The elements of the total system cost are research and development (RDE), annual operating costs (d(N,1)), program management costs (d(N,4)), and capital costs (d(N,5)). This cost represents the amount of financing that will be necessary to fund the program; that is, the amount of revenue required to support the program. Acknowledging that some costs have been neglected, we group all these under one cost category U(N). We can then write the total annual system cost by year or alternative program as:

$$TSC(N) = RDE + d(N,1) + d(N,4) + d(N,5) + U(N) \ .$$

USING THE COST MODEL

This section explains the operation of the R-3 model, an example model that incorporates the cost-estimating methods previously described. In addition, it explores the use of the model in determining the financial viability of an educational program faced with growth problems and budget constraints. The model assists the planner in analyzing the effects of growth over time, thus forestalling possible budget crises. Another use of the cost model examined is for comparing the costs of alternative programs created by changing the input variables.

Operation of the R-3 Cost Model

The model operates as follows:

a. The user activates the JOSS console† and recalls the R-3 model from the disk file (see Fig. 13a).
b. The computer asks the user if he would like an introduction to the model. A 'yes' response causes the explanation in Fig. 13b to be printed out.
c. Next, the computer asks the user whether he wishes to analyze one program over time or compare alternative programs for a given period (Fig. 13c).

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†JOSS is the trademark and service mark of The Rand Corporation for its computer program and services using that program.

d. The computer then requests a number designating the mode of user preference (the various modes are explained below) and sets the query mode of the program accordingly (Fig. 13d).

e. The computer recalls into memory the "base-case" inputs consisting of costs and quantities of resources available under the current program.

f. The computer asks the user which of the following actions he wishes to take (Fig. 13e):

   1. Have an input table displayed;
   2. Change a value in a table;
   3. Have the results printed out;
   4. Create an alternate program;
   5. Quit.

g. Whenever one of actions (1) through (4) is completed, the computer will repeat step f. If action 5 is specified, the program is terminated.

More detailed explanations of the modes of interaction and user actions available are presented below.

Modes. In designing any computerized model that requires frequent man-machine interaction, the preferences of the potential users for various modes of interaction with the computer should be considered. "Modes of interaction" refers to the nature of the query-response exchange between user and computer in an on-line system.

The modes available on a given system are in part determined by the means of interaction--the hardware. Means of interaction include, for example, cards, tapes, and consoles. The R-3 model is available through a typewriter console. The problem is to determine the modes available on the typewriter console that facilitate the transfer of information between the user and the computer. For the R-3 model, three possible modes were determined:

```
Use file 284 (K9490).
Roger.
Recall item 25 (K9490).
Done.
Do part 30.
```

a

```
Do you want an introduction to this routine? Yes=1,No=2. = 1
     This routine calculates the costs for the current San Jose
R-3 program (the base case/the base year) and alternative
programs or future years planned by you.  You will be asked
to indicate whether you wish to compare alternative programs
for a given period or to analyze one program over time.
     There are 5 actions you may take in manipulating the
routine:

     1.  Display a table;                          (Display)
     2.  Change a value;                           (Change)
     3.  Output results;                           (Output)
     4.  Create a new alternative/new year;(Alternative)(NewYear)
     5.  Quit.                                     (Quit)

The first two actions require short explanations. 'Display'
will cause the routine to print one of 4 input tables:

     Table 1:  Inputs Per Subject
     Table 2:  Inputs Per Activity
     Table 3:  Inputs Per Teacher
     Table 4:  Inputs Per Classroom

You specific which table by typing the table number when it
is requested.  As you 'change' values in these tables you may
wish to have the tables displayed again with the new values.
     A value in one of these tables may be changed by typing
'2' for action and then the table number, column number and row
number associated with the value.  If all values in a column are
to be changed to the same number, type '0' when the row number is
requested.  Similarly, to change all values in a row, type '0'
when the column number is requested.
     There are 3 modes of interaction available:

     Mode 1:  Queries by sentence; requires yes/no response.
     Mode 2:  Queries by phrase; requires code response.
     Mode 3:  Queries by word; requires code response.

It is recommended that Version 1 is used the first time through
the routine.  Now let's get started.
```

b

```
Do you want to 'analyze' one program over time or
'compare' alternative programs for a given period?
Analyze=1, Compare=2. = 1
```

c

```
Mode = 2
```

d

```
Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 1
Table Number = 1
```

e

Fig. 13--Model Introduction

Mode	Description	Example
1	Query by sentence; a coded yes/no response required.	Do you want to have a table displayed? Yes = 1, No = 2.
2	Query by phrase; a coded action response required.	Action (Display = 1, Change = 2, Output = 3, Alternatives = 4, Quit = 5).
3	Query by word; a coded action response required.	Action .

Mode 1 definitively conveys the information necessary to make a knowledgeable response. Mode 2 conveys less information, relying more upon the user's understanding of actions available. Mode 3 provides the least amount of information and requires user for knowledge or assumptions of actions available.

The simplest approach in designing a computerized model would be to utilize Mode 1, which meets the information needs of all users. However, to satisfy those first-time users who find Mode 1 inhibiting, but primarily in recognition that users' preferences change with time and use of the model, all three modes were programmed into the R-3 model. Appendix D demonstrates sessions using each of the modes.

Action 1. If Action 1 is specified, the computer requests the input table number and then types out that table. As described earlier, there are four tables available that initially contain the input values (costs and quantities) used to determine the costs of the base-case program. Looking at the tables in Figs. 7-9, the reader sees that Action 1 has been specified to print out the tables using Mode 2.

After an Action 2, as explained below, is taken, the input tables will contain changed values defining the alternative program/year being created. The user may then wish to have the table with the new values displayed again.

Action 2. To create an alternative program or year, the user must change one or more values in the input tables. When he specifies Action 2, the computer requests the input table number, the column number, and

the row number of the value to be changed, and then the new value. An example of this exchange is given in Fig. 14, lines 1 and 4, where the cost of materials per student is increased.

The model permits changing all values in a row or column to the same number in one step. If all values in a column are to be changed, the user types '0' when the row number is requested. Similarly, to change all values in a row to the same number, he would type '0' when the column number is requested. In Fig. 14, for example, the cost of materials per student for all subjects is first increased to $20 in one action, and then to $30.

Action 3. If Action 3 is specified (Fig. 14, line 5), the computer calculates the costs and resources required for the program currently in memory, and files the results on disk. The method of calculating these costs and quantities is explained on pp. 72-87. Next, the computer recalls from the file the costs and resource requirements for all programs created during the session, and displays the results for the base case and the alternative programs or years in the 4 output tables. The user may optionally request output Table 5. The results of the changes made in the cost of materials (Fig. 14) are displayed in Figs. 11 and 12.

Action 4. The user may notify the computer that he wishes to create a new alternative/year, bypassing output for the moment, by specifying Action 4. The computer, using the input values in memory, calculates the results of the current alternative or year and stores them in a file with the results of other programs/years (if any). The user, if he is comparing alternative programs, may either restore the base-case values to the input tables or retain the current alternative input value (Fig. 14, line 3). When analyzing a program over time, the current values are always retained. As a final step, the computer increases the number of alternatives by one. An example of this exchange appears on line 2, Fig. 14.

Action 5. This action terminates the computer program (see Fig. 12).

```
Action(Display=1,Change=2,Output=3,Alternative=4,Quit=5) = 2        -- line 1
Table Number = 1

Column Number  = 0
Row Number  = 10
New Value = 20

Action(Display=1,Change=2,Output=3,Alternative=4,Quit=5) = 4        -- line 2


Do you want the base case values restored to the input tables
or do you want the tables to retain the current alternative         -- line 3
program values? Restore=1, Retain=2. = 2

Action(Display=1,Change=2,Output=3,Alternative=4,Quit=5) = 2        -- line 4
Table Number = 1

Column Number  = 0
Row Number  = 10
New Value = 30

Action(Display=1,Change=2,Output=3,Alternative=4,Quit=5) = 3        -- line 5
```

Fig. 14--Cost of Materials Increase: Two Alternatives

Analysis Over Time. Let us assume that a school administrator of a demonstration program (e.g., the R-3) is concerned with the effect of a yearly increase in enrollment on his annual budget. He must determine whether forecasted revenues can finance such increases. In order to examine this problem, the school administrator needs a model of revenues as well as costs. The revenue model specifies the sources and estimates the amounts of funds available for school investment and operating costs. It is not the purpose of this report, however, to develop a revenue model. Therefore, we assume that a revenue model exists and revenue estimates have been made.

To begin to estimate costs, the administrator must examine the input tables and specify the changes he foresees. Assume that he expects a 10-percent increase in enrollment in each subject and activity per year and that he wishes to examine a 5-year period. Recalling from previous displays that the enrollment values appear in input Table 1, Row 1, and input Table 2, Row 3, he is in a position to change them through an Action 2. In Fig. 15 we see that he is increasing enrollment to 385 for the first year. Recall that the 0 input for a column means that all the values in the specified row are to be changed to the same value.

After the administrator makes these changes, he decides to have the altered Tables 1 and 2 redisplayed with the new values (see Fig. 16). Satisfied that the new values have been stored, he starts a new year by specifying Action 4. Then, as before, he changes input Table 1 and input Table 2 enrollment figures. Finally, he creates Year 3, Year 4, and Year 5. These exchanges appear in Fig. 17. Now he requests output by specifying Action 3. The results are displayed in Figs. 18-19. The administrator is horrified to discover that his annual operating cost increases approximately 67 percent in 5 years while capital costs increase 700 percent.

When this program budget is combined with revenue estimates for each year, it can be determined if the program can accept a yearly increase in enrollment without cutting back on spending. Assume that revenues are fixed to meet the budget of the base case ($304843 + $142000 + $3000) and, therefore, the administrator must cut back somewhere in the program. Examining the output tables, the administrator notes that

```
Use file 284 (K9490).
Roger.
Recall item 25 (K9490).
Done.
Do part 30.


Do you want an introduction to this routine? Yes=1,No=2. = 2


Do you want to 'analyze' one program over time or
'compare' alternative programs for a given period?
Analyze=1, Compare=2. = 1


Mode = 2

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 1

Column Number  = 0
Row Number  = 1
New Value = 385

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 2

Column Number  = 0
Row Number  = 3
New Value = 385

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 1
Table Number = 1
```

Fig. 15--10-Percent Enrollment Increase, First Year

TABLE 1: INPUTS PER SUBJECT

	1. Read	2. Math	3. Hum	4. R-3
1. Enrollment	385	385	385	385
2. Classhrs/wk/stud	10	9	8	3
Class Size				
3. Program	20	20	20	20
4. District	30	30	30	30
Classroom Req.				
5. Regular	0	1	1	0
6. Special	1	0	0	1
Teacher Manhrs/Classhr				
7. Regular	1.00	1.00	1.00	1.00
8. Specialists	.50	.50	.50	.50
9. Aides	.50	.50	.50	.50
10.$Materials/yr/stud	15	10	10	8

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 1
Table Number = 2

Fig. 16--Input Table 1 With a 10-Percent Enrollment Increase

TABLE 2: INPUTS PER ACTIVITY

		1. Field Tr.	2. Inten.Inv.	3. Par.Inv.
1.	Number/year	4	2	2
2.	Length in days	1.00	4.00	1.00
3.	Enrollment	385	385	385
4.	Teachers/student	.03	.05	.03
5.	No. consultants	0	2	1
6.	No. add. participants	0	0	250
7.	$Food/person/day	.00	1.00	1.25
8.	$Lodge/person/day	.00	.50	.00
9.	$/mile/bus	.25	.30	.00
10.	Avg. mileage	50	200	0
11.	Max bus capacity	60	80	0
	Salary/Add.Part./Day			
12.	Consultants	50	50	50
13.	Bus drivers	35	45	0

```
Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 4

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 1

Column Number  = 0
Row Number  = 1
New Value = 423

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 2

Column Number  = 0
Row Number  = 3
New Value = 423

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 4

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 1

Column Number  = 0
Row Number  = 1
New Value = 465
```

Fig. 17--10-Percent Enrollment Increase, Years 2 Through 5

```
Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 2

Column Number  = 0
Row Number  = 3
New Value = 465

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 4

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 1

Column Number  = 0
Row Number  = 1
New Value = 511

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 2

Column Number  = 0
Row Number  = 3
New Value = 511

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 4

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 1

Column Number  = 0
Row Number  = 1
New Value = 562

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 2

Column Number  = 0
Row Number  = 3
New Value = 562

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 3
```

Fig. 17--Continued

TABLE 1

	Total Cost	Cost/ Student	Inc.Cost/ Student	Program Mgmt.Cost	Additional Capital
Base Year (0)	304843.33	870.98	.00	142000.00	3000.00
Year 1	342041.00	888.42	17.44	142000.00	8000.00
Year 2	368475.34	871.10	-17.32	142000.00	13500.00
Year 3	405976.00	873.07	1.97	142000.00	11000.00
Year 4	432873.33	847.11	-25.96	142000.00	13500.00
Year 5	493893.00	878.81	31.70	142000.00	21500.00

TABLE 2: COST ELEMENT SUMMARY

	Sal	Matl	Mt. Equ	Ins. Trg.	Fd.+ Lodg	Tran	Tot	Cap Rms	Cap Equ	Cap Rem
Base Year (0)	2736	151	26	66	60	10	3048	0	10	20
Year 1	3076	166	29	73	66	11	3420	70	10	0
Year 2	3307	182	32	81	72	11	3685	120	15	0
Year 3	3647	200	34	88	78	12	4060	100	10	0
Year 4	3879	220	37	95	85	13	4329	120	15	0
Year 5	4441	242	42	106	93	15	4939	190	25	0

Fig. 18--Output Tables 1 Through 4 Resulting From
A 10-Percent Enrollment Increase Per Year For a 5-Year Period

TABLE 3: PROGRAM COMPONENT SUMMARY

	Read	Math	Hum	R-3	FT	II	PI	Tot
Base Year (0)	987	870	777	308	13	77	16	3048
Year 1	1108	977	873	346	13	86	17	3420
Year 2	1194	1053	940	373	15	91	18	3685
Year 3	1315	1161	1037	411	15	101	19	4060
Year 4	1403	1237	1105	439	17	107	20	4329
Year 5	1603	1413	1263	501	19	119	22	4939

TABLE 4: PHYSICAL DATA

	Teachers			Classrooms					
				No.Req.		No.Rem.		No.Add.	
	Reg	Spec	Aide	Reg	Spec	Reg	Spec	Reg	Spec
Base Year (0)	18	17	17	10	8	1	0	0	0
Year 1	20	19	19	11	9	0	0	0	1
Year 2	22	21	21	12	10	0	0	1	1
Year 3	24	23	23	14	10	0	0	2	0
Year 4	26	25	25	15	11	0	0	1	1
Year 5	29	28	28	16	13	0	0	1	2

Do you want a summary of the costs of alternative programs by program component and cost element? Yes=1, No=2. = 1

Fig. 18--Continued

TABLE 5: COST ELEMENT, PROGRAM COMPONENT SUMMARY

	Read	Math	Hum	R-3	FT	II	PI	Tot
*SALARIES								
Base Year (0)	900	810	720	270	10	26	1	2736
Year 1	1012	911	810	304	10	30	1	3076
Year 2	1089	980	871	327	11	30	1	3307
Year 3	1201	1081	961	360	11	33	1	3647
Year 4	1277	1150	1022	383	13	33	1	3879
Year 5	1463	1317	1171	439	14	37	1	4441
*MATERIALS								
Base Year (0)	53	35	35	28	0	0	0	151
Year 1	58	39	39	31	0	0	0	166
Year 2	63	42	42	34	0	0	0	182
Year 3	70	47	47	37	0	0	0	200
Year 4	77	51	51	41	0	0	0	220
Year 5	84	56	56	45	0	0	0	242
*EQUIPMENT MT.								
Base Year (0)	12	5	5	4	0	0	0	26
Year 1	14	6	5	4	0	0	0	29
Year 2	15	6	6	5	0	0	0	32
Year 3	15	7	7	5	0	0	0	34
Year 4	17	8	7	5	0	0	0	37
Year 5	20	8	8	6	0	0	0	42
*INSERVICE TRG.								
Base Year (0)	22	20	18	7	0	0	0	66
Year 1	24	22	20	7	0	0	0	73
Year 2	27	24	22	8	0	0	0	81
Year 3	29	26	23	9	0	0	0	88
Year 4	32	29	25	10	0	0	0	95
Year 5	35	32	28	11	0	0	0	106
*FOOD + LODGING								
Base Year (0)	0	0	0	0	0	45	15	60
Year 1	0	0	0	0	0	50	16	66
Year 2	0	0	0	0	0	54	17	72
Year 3	0	0	0	0	0	60	18	78
Year 4	0	0	0	0	0	66	19	85
Year 5	0	0	0	0	0	72	21	93
*TRANSPORTATION								
Base Year (0)	0	0	0	0	4	6	0	10
Year 1	0	0	0	0	4	7	0	11
Year 2	0	0	0	0	4	7	0	11
Year 3	0	0	0	0	4	8	0	12
Year 4	0	0	0	0	5	8	0	13
Year 5	0	0	0	0	5	10	0	15

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 5

Fig. 19--Output Table 5 Resulting From a 10-Percent Enrollment Increase Per Year For a 5-Year Period

salaries for instructional personnel are the greatest factor in determining annual operating costs (Fig. 19). He also sees that capital costs are increasing due to the need to construct more rooms. Thus, one option is to increase the class size at the same rate that enrollment increases in order to keep the requirements for teachers and rooms constant.

Obviously, this is not a feasible solution because there is an upper bound on the number of students one teacher can handle and one classroom can hold and still have the quality of instruction remain intact. A variation on this option would be to increase the class size by a specific amount from Year 1 in an attempt to determine how long the existing sources of revenue will satisfy budget needs. Figures 20 and 21 display the session at the terminal creating this alternative program in which class size is increased from 20 to 24 students and enrollment is increased 10 percent per year for 5 years. Note that Table 1, Row 3 (Program Class Size) need only be changed once because this value is retained as each year's changes in enrollment are recorded. The new output is displayed in Figs. 22 and 23. It can be seen that sufficient funds are available up to Year 3, when new sources of revenue must be sought.

With the knowledge of impending financial pressure in Year 3, the administrator must select a course of action to prepare for this budget increase. Of course, one action would be to do nothing in the hopes that new sources or increased amounts of funds would become available by Year 3. A more positive step would be to start a campaign in the community to pass an increase in the school tax rate. He could also lobby for more State and Federal aid to the school district. In addition to these actions, the administrator should prepare contingency plans in case revenue is not increased. To help formulate these plans, the administrator can use the model to determine high-cost areas and the effects on costs of cut-backs in these areas.

An important expansion of the model for ease in analyzing programs over time would be the addition of an input table of growth factors. Thus, the user could specify once that enrollment, for example, will increase 10 percent per year rather than inputting the values for each year.

```
Use file 284 (K9490).
Roger.
Recall item 25 (K9490).
Done.
Do part 30.


Do you want an introduction to this routine? Yes=1,No=2. = 2


Do you want to 'analyze' one program over time or
'compare' alternative programs for a given period?
Analyze=1, Compare=2. = 1


Mode = 2

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 1

Column Number  = 0
Row Number  = 3
New Value = 24

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 1

Column Number  = 0
Row Number  = 1
New Value = 385

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 2

Column Number  = 0
Row Number  = 3
New Value = 385

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 4

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 1

Column Number  = 0
Row Number  = 1
New Value = 423

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 2

Column Number  = 0
Row Number  = 3
New Value = 423
```

Fig. 20--10-Percent Enrollment Increase,
20 Percent Class Size Increase, Years 1 and 2

```
Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 4

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 1

Column Number  = 0
Row Number  = 1
New Value = 465

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 2

Column Number  = 0
Row Number  = 3
New Value = 465

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 4

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 1

Column Number  = 0
Row Number  = 1
New Value = 511

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 2

Column Number  = 0
Row Number  = 3
New Value = 511

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 4

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 1

Column Number  = 0
Row Number  = 1
New Value = 562

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 2

Column Number  = 0
Row Number  = 3
New Value = 562

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 3
```

Fig. 21--10-Percent Enrollment Increase,
20 Percent Class Size Increase, Years 3 Through 5

TABLE 1

	Total Cost	Cost/ Student	Inc.Cost/ Student	Program Mgmt.Cost	Additional Capital
Base Year (0)	304843.33	870.98	.00	142000.00	3000.00
Year 1	274041.00	711.79	-159.19	142000.00	.00
Year 2	277875.33	656.92	-54.88	142000.00	.00
Year 3	315476.00	678.44	21.53	142000.00	8000.00
Year 4	342373.33	670.01	-8.44	142000.00	13500.00
Year 5	380593.00	677.21	7.21	142000.00	11000.00

TABLE 2: COST ELEMENT SUMMARY

	Sal	Matl	Mt. Equ	Ins. Trg.	Fd.+ Lodg	Tran	Tot	Cap Rms	Cap Equ	Cap Rem
Base Year (0)	2736	151	26	66	60	10	3048	0	10	20
Year 1	2412	166	24	62	66	11	2740	0	0	0
Year 2	2422	182	26	66	72	11	2779	0	0	0
Year 3	2762	200	29	73	78	12	3155	70	10	0
Year 4	2993	220	32	81	85	13	3424	120	15	0
Year 5	3335	242	34	88	93	15	3806	100	10	0

Fig. 22--Output Tables 1 Through 4 Resulting From a 10-Percent Enrollment Increase Per Year and a 20-Percent Class-Size Increase Per Year for a 5-Year Period

TABLE 3: PROGRAM COMPONENT SUMMARY

	Read	Math	Hum	R-3	FT	II	PI	Tot
Base Year (0)	987	870	777	308	13	77	16	3048
Year 1	880	774	692	277	13	86	17	2740
Year 2	891	781	699	282	15	91	18	2779
Year 3	1014	889	796	320	15	101	19	3155
Year 4	1101	966	864	348	17	107	20	3424
Year 5	1223	1075	962	387	19	119	22	3806

TABLE 4: PHYSICAL DATA

	Teachers			Classrooms					
				No.Req.		No.Rem.		No.Add.	
	Reg	Spec	Aide	Reg	Spec	Reg	Spec	Reg	Spec
Base Year (0)	18	17	17	10	8	1	0	0	0
Year 1	17	16	16	10	7	0	0	0	0
Year 2	18	17	17	10	8	0	0	0	0
Year 3	20	19	19	11	9	0	0	0	1
Year 4	22	21	21	12	10	0	0	1	1
Year 5	24	23	23	14	10	0	0	2	0

Do you want a summary of the costs of alternative programs by program component and cost element? Yes=1, No=2. = 1

Fig. 22--Continued

TABLE 5: COST ELEMENT, PROGRAM COMPONENT SUMMARY

	Read	Math	Hum	R-3	FT	II	PI	Tot
*SALARIES								
Base Year (0)	900	810	720	270	10	26	1	2736
Year 1	791	712	632	237	10	30	1	2412
Year 2	793	714	635	238	11	30	1	2422
Year 3	906	815	724	272	11	33	1	2762
Year 4	982	884	786	295	13	33	1	2993
Year 5	1094	985	875	328	14	37	1	3335
*MATERIALS								
Base Year (0)	53	35	35	28	0	0	0	151
Year 1	58	39	39	31	0	0	0	166
Year 2	63	42	42	34	0	0	0	182
Year 3	70	47	47	37	0	0	0	200
Year 4	77	51	51	41	0	0	0	220
Year 5	84	56	56	45	0	0	0	242
*EQUIPMENT MT.								
Base Year (0)	12	5	5	4	0	0	0	26
Year 1	11	5	5	3	0	0	0	24
Year 2	12	5	5	4	0	0	0	26
Year 3	14	6	5	4	0	0	0	29
Year 4	15	6	6	5	0	0	0	32
Year 5	15	7	7	5	0	0	0	34
*INSERVICE TRG.								
Base Year (0)	22	20	18	7	0	0	0	66
Year 1	21	19	17	6	0	0	0	62
Year 2	22	20	18	7	0	0	0	66
Year 3	24	22	20	7	0	0	0	73
Year 4	27	24	22	8	0	0	0	81
Year 5	29	26	23	9	0	0	0	88
*FOOD + LODGING								
Base Year (0)	0	0	0	0	0	45	15	60
Year 1	0	0	0	0	0	50	16	66
Year 2	0	0	0	0	0	54	17	72
Year 3	0	0	0	0	0	60	18	78
Year 4	0	0	0	0	0	66	19	85
Year 5	0	0	0	0	0	72	21	93
*TRANSPORTATION								
Base Year (0)	0	0	0	0	4	6	0	10
Year 1	0	0	0	0	4	7	0	11
Year 2	0	0	0	0	4	7	0	11
Year 3	0	0	0	0	4	8	0	12
Year 4	0	0	0	0	5	8	0	13
Year 5	0	0	0	0	5	10	0	15

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 5

Fig. 23--Output Table 5 Resulting From a 10-Percent Enrollment Increase Per Year and a 20-Percent Class-Size Increase For a 5-Year Period

Comparison of Alternative Programs. The previous discussion analyzed one program over time per session at the terminal. Two sessions were required in this case to create alternative programs. The model also permits the user to create, during one session, up to seven alternative programs during one time period (a year). This section attempts to demonstrate the purpose of this option.

Quite reasonably, we might expect the costs of various resources (remodelling classrooms, teachers' salaries, etc.) to differ from our estimates. For example, unions--demanding ever-increasing wages--and inflation are two strong upward forces on resource costs. Therefore, a school administrator should examine alternative programs that incorporate other likely cost projections. In this way, he becomes aware of what could happen, and can plan accordingly. As an example case, assume that our administrator is currently faced with a teachers' strike (regular teachers for higher salaries). The final settlement, he has determined, will result in either no increase in salary, a 5-percent increase, or a 10-percent annual increase in salary in the next fiscal year. He inputs these changes into the model, as shown in Fig. 24; the resulting output is displayed in Figs. 25 and 26. The base-case results represent the "no increase" alternative.

It is seen that anything other than a stable salary level causes financial pressure on the program. The 10-percent annual increase, for example, would require an additional $8103. Note that this additional amount covers only the incremental number of regular teachers required by the special program. If the total number of regular teachers were to be considered, the impact of a 10-percent annual increase in salary would have been much greater. The increase implies that the cost of an educational program is sensitive to the level of teachers' salaries. The administrator may then hope that the strike settlement will result in no salary increases. However, a constant salary level may lead to other difficulties, such as maintaining an adequate staff for delivering quality education. In any event, the administrator is now aware of his financial position under the three possible outcomes; this should aid him in planning for the next year.

```
Use file 284 (K9490).
Roger.
Recall item 25 (K9490).
Done.
Do part 30.


Do you want an introduction to this routine? Yes=1,No=2. = 2


Do you want to 'analyze' one program over time or
'compare' alternative programs for a given period?
Analyze=1, Compare=2. = 2


Mode = 2

Action(Display=1,Change=2,Output=3,Alternative=4,Quit=5) = 2
Table Number = 3

Column Number  = 3
Row Number  = 1
New Value = 11550

Action(Display=1,Change=2,Output=3,Alternative=4,Quit=5) = 4


Do you want the base case values restored to the input tables
or do you want the tables to retain the current alternative
program values? Restore=1, Retain=2. = 2

Action(Display=1,Change=2,Output=3,Alternative=4,Quit=5) = 2
Table Number = 3

Column Number  = 3
Row Number  = 1
New Value = 12100

Action(Display=1,Change=2,Output=3,Alternative=4,Quit=5) = 3
```

Fig. 24--5- and 10-Percent Increases in Regular Teachers' Salaries

TABLE 1

	Total Cost	Cost/ Student	Inc.Cost/ Student	Program Mgmt.Cost	Additional Capital
Base Case	304843.33	870.98	.00	142000.00	3000.00
Alternative 1	308895.00	882.56	11.58	142000.00	.00
Alternative 2	312946.67	894.13	11.58	142000.00	.00

TABLE 2: COST ELEMENT SUMMARY

	Sal	Matl	Mt. Equ	Ins. Trg.	Fd.+ Lodg	Tran	Tot	Cap Rms	Cap Equ	Cap Rem
Base Case	2736	151	26	66	60	10	3048	0	10	20
Alternative 1	2773	151	26	69	60	10	3089	0	0	0
Alternative 2	2811	151	26	73	60	10	3129	0	0	0

TABLE 3: PROGRAM COMPONENT SUMMARY

	Read	Math	Hum	R-3	FT	II	PI	Tot
Base Case	987	870	777	308	13	77	16	3048
Alternative 1	1000	882	788	312	13	77	16	3089
Alternative 2	1014	894	799	316	13	77	16	3129

TABLE 4: PHYSICAL DATA

	Teachers			Classrooms					
	Reg	Spec	Aide	No.Req.		No.Rem.		No.Add.	
				Reg	Spec	Reg	Spec	Reg	Spec
Base Case	18	17	17	10	8	1	0	0	0
Alternative 1	18	17	17	10	8	0	0	0	0
Alternative 2	18	17	17	10	8	0	0	0	0

Do you want a summary of the costs of alternative programs by program component and cost element? Yes=1, No=2. = 1

Fig. 25--Output Tables 1 Through 4 Resulting From 5- and 10-Percent Increases in Regular Teachers' Salaries

TABLE 5: COST ELEMENT, PROGRAM COMPONENT SUMMARY

	Read	Math	Hum	R-3	FT	II	PI	Tot
*SALARIES								
Base Case	900	810	720	270	10	26	1	2736
Alternative 1	912	821	730	274	10	26	1	2773
Alternative 2	925	832	740	277	10	26	1	2811
*MATERIALS								
Base Case	53	35	35	28	0	0	0	151
Alternative 1	53	35	35	28	0	0	0	151
Alternative 2	53	35	35	28	0	0	0	151
*EQUIPMENT MT.								
Base Case	12	5	5	4	0	0	0	26
Alternative 1	12	5	5	4	0	0	0	26
Alternative 2	12	5	5	4	0	0	0	26
*INSERVICE TRG.								
Base Case	22	20	18	7	0	0	0	66
Alternative 1	23	21	18	7	0	0	0	69
Alternative 2	24	22	19	7	0	0	0	73
*FOOD + LODGING								
Base Case	0	0	0	0	0	45	15	60
Alternative 1	0	0	0	0	0	45	15	60
Alternative 2	0	0	0	0	0	45	15	60
*TRANSPORTATION								
Base Case	0	0	0	0	4	6	0	10
Alternative 1	0	0	0	0	4	6	0	10
Alternative 2	0	0	0	0	4	6	0	10

Action(Display=1,Change=2,Output=3,Alternative=4,Quit=5) = 5

Fig. 26--Output Table 5 Resulting From
5- and 10-Percent Increases in Regular Teachers' Salaries

Appendix A

PROJECT R-3 ALLOCATION OF STUDENTS AMONG GROUPS

Before the semester was underway, it was necessary to divide the seventh graders into class-size groups. The groups were to be internally heterogeneous with respect to sex and scholastic abilities, but between-group differences were to be small; thus, there would be no semblance of tracking and each group could be regarded, to some extent, as a separate replication of the same experiment. The guiding strategy was to establish an objectively reproducible selection procedure, a method free of intentional or unintentional bias.

There were to be 12 groups of equal size; each group would have proportional representation by sex and each would represent a full range of reading and arithmetic abilities as manifested in raw scores achieved on the CAT, which was administered in January.

At the start of the semester, February 2, 253 students were enrolled (136 boys and 117 girls). Five students had not taken all of the CAT tests, but were assigned proxy scores.[†] The mean and median

---

[†]Proxies for three students were extrapolated from relative placements in the Title I testing administered the previous October:

$$_i\tilde{X}_J = \bar{X}_J + S_J\left(\frac{_iX_o - \bar{X}_o}{S_o}\right),$$

where $_i\tilde{X}_J$ = proxy for the *i*th student,

$\bar{X}_J$ = mean score of the January testing,

S_J = standard deviation of the January testing,

$\bar{X}_o$ = mean score of the October testing,

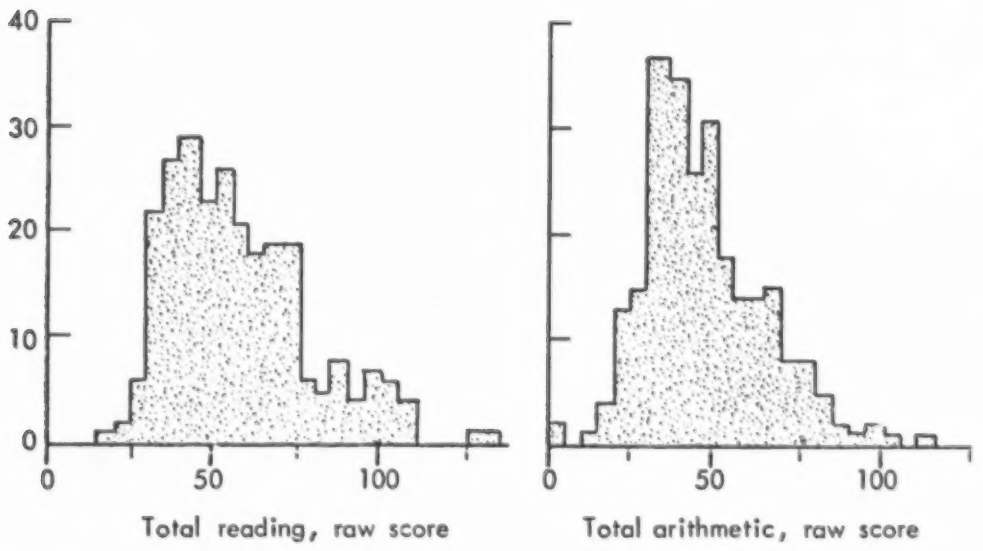
S_o = standard deviation of the October testing,

$_iX_o$ = score received by the *i*th student on the October test.

Since the previous test included only Title I students, who presumably

raw scores were:

	Mean	Median
Total reading	57.52	53
Total arithmetic	47.26	44



We now describe the scheme used to allocate 252 students into 12 groups of 21, such that each group contains 3 students from each of 7 reading-ability rankings (reading septiles) and from each of 7 arithmetic-ability rankings (arithmetic septiles).† The remaining student was to be arbitrarily assigned to one of the groups.

The students were first ordered according to the reading raw scores. The top 36 students were assigned to the first septile, the

---

would score lower on the average, the respective assignments probably are positively biased.

Because the other two students were not included in the October testing, the January test data corresponding to the nonmissing score were substituted. For example, if the reading score was missing for the *i*th student:

$$i\bar{X}_{read} = \bar{X}_{read} + S_{read}\left(\frac{iX_{math} - \bar{X}_{math}}{S_{math}}\right)$$

†The choice of 7 ability rankings (rather than, say, 5 or 10 rankings) was primarily a matter of convenience. For the problem at hand, the number of rankings could have been as small as 2 or as large as 21. Smaller numbers would provide less heterogeneity and larger numbers would allow less freedom for allocating the sexes. The "sensible range" for this case would therefore lie between 5 and 12. Since the allocation procedure is more straightforward if the number of rankings is an exact divisor of the group size, the likely candidate for this case is 7 rankings.

next 36 students were assigned to the second septile, and so on down to the last (seventh) septile. Each student was assigned a number corresponding to his reading septile. Next, the students were similarly divided into arithmetic septiles, and assigned corresponding identifiers. Using the two-digit identifier thus assigned, the joint distribution of students across the two ability measures was charted on a 7 by 7 matrix:

Reading Septiles \ Arithmetic Septiles	1	2	3	4	5	6	7	
1	21	8	4	2	0	1	0	36
2	7	11	11	3	2	1	1	36
3	5	9	4	7	4	5	2	36
4	2	5	5	12	3	6	3	36
5	1	1	8	8	3	6	9	36
6	0	2	1	3	16	9	5	36
7	0	0	3	1	8	8	16	36
	36	36	36	36	36	36	36	252

The numbers in the cells indicate how many students were in the respective categories; numbers on the margins provide row (reading septile) and column (arithmetic septile) totals.

A distribution pattern for each of the 12 groups was designated (in sequence) by choosing 3 non-zero cells from each row and from each column of the matrix.

After each pattern was designated, the cell numbers were decremented by the number of selections from the respective cells and the marginal totals were adjusted to reflect the new sums. When designating any particular pattern, it was permissible to select the same cell more than once; the selection rules were:

1. If the cell number was zero, the cell could not be chosen;
2. If the cell number was non-zero but less than one-third the margin total, it could be chosen once;
3. If the number was one-third the margin total, the cell had to be chosen;

4. If the number was between one-third and two-thirds of the margin total, the cell had to be chosen once but could also be chosen twice;
5. If the number was two-thirds the margin total, the cell had to be chosen twice.

These rules guaranteed that pattern designation would proceed in such a manner that the 12 patterns could be exactly accommodated by the 252 students. Furthermore, the rules precluded the necessity to select a cell three times and minimized the need for double selections. Within these restrictions, care was taken to distribute each pattern fairly evenly over the matrix. The selection of the first two and last two patterns is indicated by the asterisks in the illustration below:

Pattern 1

21**	8*	4	2	0	1	0	36
7*	11	11*	3	2	1	1	36
5	9	4	7*	4	5*	2	36
2	5	5*	12*	3*	6	3	36
1	1	8*	8*	3	6	9*	36
0	2	1	3	16*	9*	5*	36
0	0	3	1	8*	8*	16*	36
36	36	36	36	36	36	36	252

Pattern 2

19*	7*	4*	2	0	1	0	33
6*	10*	10*	3	2	1	1	33
5*	8*	4	6*	4	4	2	33
2	5	4	11*	2*	6*	3	33
1	1	7*	7*	3	6	8*	33
0	2	1	3	15*	8*	4*	33
0	0	3	1	7*	7*	15*	33
33	33	33	33	33	33	33	231

Pattern 11

4**	1	1*	0	0	0	0	6
1*	1	1*	1	0	1*	1	6
0	1*	1	2*	1	1*	0	6
1	1*	1	2*	0	1*	0	6
0	1	1	1*	1*	1	1*	6
0	1*	0	0	4**	1	0	6
0	0	1*	0	0	1	4**	6
6	6	6	6	6	6	6	42

Pattern 12

2**	1*	0	0	0	0	0	3
0	1*	0	1*	0	0	1*	3
0	0	1*	1*	1*	0	0	3
1*	0	1*	1*	0	0	0	3
0	1*	1*	0	0	1*	0	3
0	0	0	0	2**	1*	0	3
0	0	0	0	0	1*	2**	3
3	3	3	3	3	3	3	21

The next task was to match students to the patterns designated. The patterns were taken one at a time and students with identifiers matching the chosen cells were selected. This selection was arbitrary (unsystematic) except that the ratio of boys to girls was either 11 to 10 or 12 to 9 and both sexes were distributed fairly evenly over the pattern. The extra student (number 253) was arbitrarily assigned to the ninth group; his test scores would have placed him in cell 6.6.

Finally, the 12 groups were shuffled and assigned the labels used in the R-3 program (A: 1, 2, 3, 4. B: 1, 2, 3, 4. C: 1, 2, 3, 4). The 12 groups are illustrated, along with the R-3 labels, in Fig. 27. in the order of designation. Boys are indicated by Bs, girls by Gs.

It may be of interest to examine how well this procedure performed its task of allocating students into groups that uniformly mirror the central tendency and variability of the overall student population. Table 23 provides comparisons with respect to reading and arithmetic scores. The groups are identified by their R-3 codes. Means and standard deviations are given for each of the 12 groups, for each of the 3 lettered groupings (A, B, and C), and for the overall population.

It is also interesting to compare the variability of the group means with that which might have occurred had the students been allocated by simple random methods. The standard deviation of the means of the groups is computed as

$$\sqrt{\frac{\sum_{g=1}^{12} (\bar{X}_g - \bar{X}_o)^2}{12}} \quad \begin{matrix} = 1.6 \text{ (reading)} \\ = 1.6 \text{ (arithmetic)} \end{matrix}$$

where $\bar{X}_o$ is the mean for all 253 students. Had groups been allocated at random, one could have expected the standard deviations to be in the neighborhood of

$$\frac{S_o}{\sqrt{12}} \begin{cases} = 4.6 \text{ (reading)} \\ = 3.9 \text{ (arithmetic} \end{cases}$$

where S_o is the standard deviation of the overall.

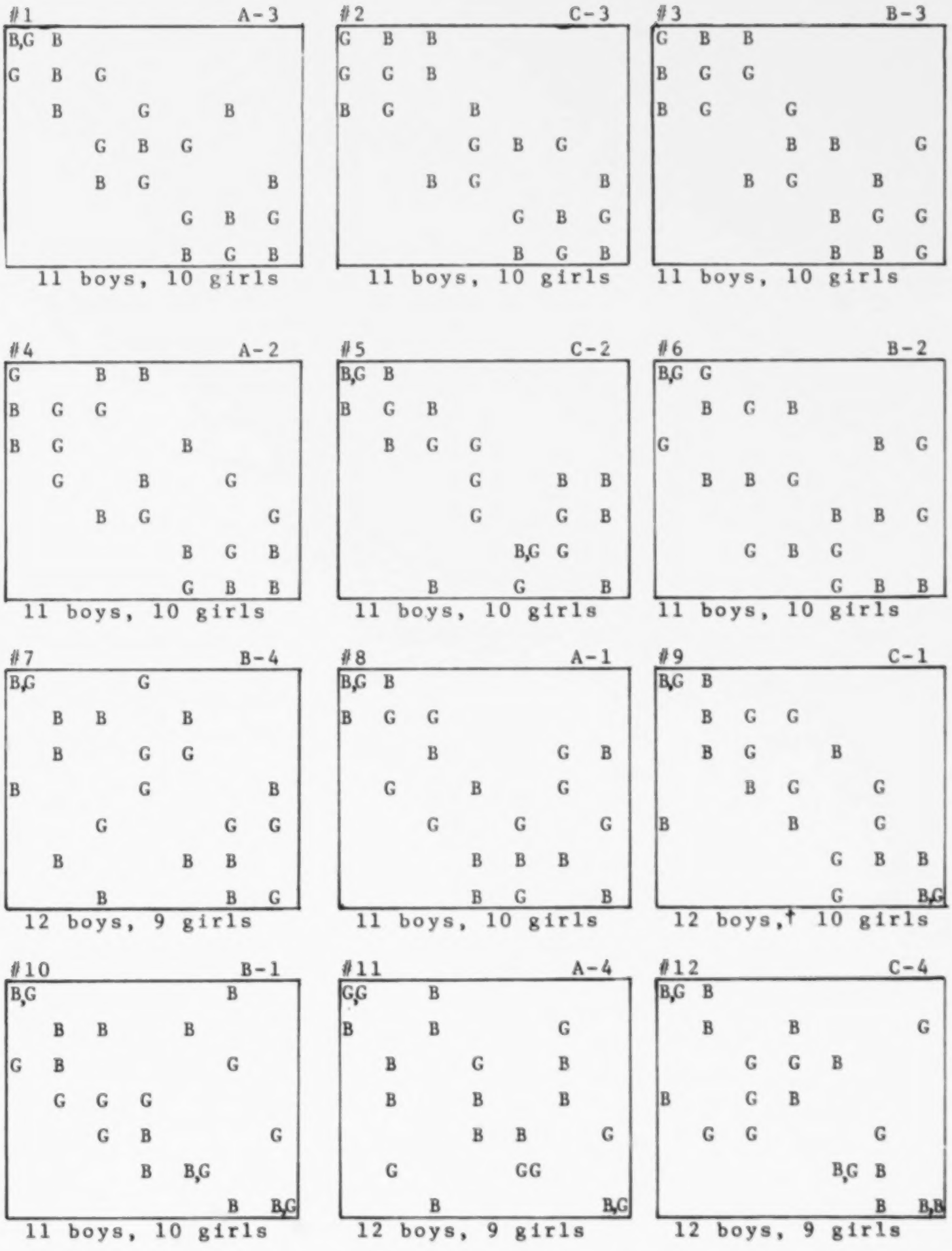


Fig. 27--Allocation of Students by Septile and Sex Among Groups

†Includes the extra student.

Table 23

GROUP MEANS AND STANDARD DEVIATIONS

Group	Reading		Arithmetic		n
	Mean	Std. Dev.	Mean	Std. Dev.	
A-1	55.52	18.77	46.95	20.12	21
A-2	56.71	19.63	47.76	16.95	21
A-3	61.38	24.99	48.86	18.50	21
A-4	55.62	16.74	46.33	16.49	21
A total	57.31	20.41	47.48	18.10	84
B-1	56.29	21.66	47.29	17.79	21
B-2	57.43	22.80	47.29	15.87	21
B-3	58.86	21.64	47.19	15.74	21
B-4	56.71	19.85	47.81	18.01	21
B total	57.32	21.54	47.39	16.89	84
C-1	56.27	19.78	44.32	18.29	22
C-2	59.29	24.42	50.86	24.20	21
C-3	59.76	20.64	46.29	16.41	21
C-4	56.48	18.79	46.33	13.91	21
C total	57.93	21.06	46.92	18.79	85
Overall	57.52	21.01	47.26	17.93	253

The sex ratio in the larger group was 136 boys to 117 girls, or 11.33/9.75. Eight of the smaller groups were assigned 11/10 ratios, three had 12/9, and one had 12/10. Short of partitioning some youngsters, there is no allocation with ratios more uniformly near that of the overall ratio (136/117).

The preceding pages describe an objective method for allocating students into groups so that each group includes the same representation of two quantitative measures of scholastic achievement. The method can easily accommodate a more flexible set of initial conditions:

1. With more effort, a third controlling variable (i.e., ranking criterion) could have been formally incorporated into the procedure. For example, students could have been ranked according to their score on the language section of the pre-test. The two-dimensional matrix, p. 111, would then become a three-dimensional matrix characterized as having seven rows (reading septiles), seven columns (arithmetic septiles), and seven files

(language septiles). Then, the allocation to each of the twelve groups would be such that three students are included from each file as well as from each row and column. Even more controls may be added, but with increasing difficulty.

2. The control variables need not be quantitative; the method would be equally useful for insuring representation across socioeconomic or cultural variables. For example, in some compensatory education programs it might be desirable to allocate students along a three-way ranking scheme using reading pretest scores for one ranking criterion, racial or ethnic characteristics for the second, and a subjective assessment of English-speaking ability for the third.
3. Although it is administratively convenient for the control variables to split the student population into rankings of equal size, this is not necessary because only the number of students selected from each ranking need be proportional. Thus, in the example above, student allocation to groups should reflect the relative sizes of the racial-ethnic rankings. (This obtains proportionality with the racial-ethnic mix of the population being considered.)

Appendix B

R-3 QUESTIONNAIRE FOR TEACHERS AND TEACHER AIDES

NAME _____

DISCUSSION

We would like to know what contributions the components of the school program under R-3 made to student learning. Because you have been able to observe student progress during the program most intimately, your opinion on this matter is of vital concern to us.

The accompanying chart presents the primary objectives of the R-3 program across the top, allowing space in items G, H, and I for you to fill in any other learning that you observed, that was due to the program, and that you believe was significant. Please explain these additional items on the sheet following the chart.

Components of the school program that may have helped bring about student attainment of one or more of the learning objectives are listed in the left-hand column of the chart.

Please rank each component listed by assigning a percentage according to its contribution to attainment of each learning objective by your classes as a whole. (Think of your average student in making these decisions.) The total of the numbers down each column should be 100 percent. If you believe that a particular component made no contribution to student attainment of a particular learning objective, enter a zero.

For example, under A, Reading Achievement, you might enter 55% for reading, 10% for gaming/simulation, 25% for humanities, 10% for in-service training, and 0 for all other components. You may make as many non-zero entries as you wish in each column as long as the total for that column is 100%. Ignore the totals across the rows.

When you have finished filling in the chart, please answer the questions on the pages that follow it.

LEARNING OBJECTIVES FOR STUDENTS
(See explanations on following page)

SCHOOL PROGRAM COMPONENTS (See explanations on following page)	A. Reading Achievement	B. Arithmetic Achievement	C. Attitude Toward School	D. Attitude Toward Adults	E. Attitude Toward Peers	F. Environmental Awareness	G. Teamwork	H. Other	I. Other	J. Other
1. Reading										
2. Arithmetic										
3. Humanities										
4. Gaming/Simulation										
5. Intensive Involvement										
6. Local Field Trips										
7. Home Visits										
8. Parent Participation										
9. Heterogeneous Grouping										
10. In-Service Training										
TOTALS (Percent)	100	100	100	100	100	100	100	100	100	100

EXPLANATIONS OF TERMS

Learning Objectives for Students

A. Improvement in reading ability

B. Improvement in mathematical ability

C. More positive attitude toward school and toward learning

D. Improved poise and courtesy in the company of adults

E. Improved ability to get along with other students

F. More realistic understanding of his environment and of his place in it

G. Better ability to work as part of a team, whether as a leader or a follower

H. Other learning you believe the program promoted (explain)

_____

_____

I. As in H. _____

_____

_____

J. As in H. _____

_____

_____

School Program Components

1. Classroom activities during the reading period
2. Classroom activities during the arithmetic period
3. Classroom activities during the humanities period
4. Classroom activities during the R-3 period, focused on gaming/simulation
5. Self explanatory
6. Self explanatory
7. Visits to students' homes by teachers and by aides
8. Parent participation in field trips, school dinners, and so on
9. Self explanatory
10. Self explanatory

ADDITIONAL INFORMATION ON COMPONENTS

1. Would you rank the contribution to a given learning objective of any of the school program components differently if you were considering their effects on only the bright students in your classes? Yes_____ No_____
2. If you answered yes, identify the component, check whether it was more or less effective for bright students than for the average in attaining the given learning objective and identify the learning objective on the form below:

Component	More Effective	Less Effective	Objective

3. Would you rank the contribution to a given learning objective of any of the school program components differently if you were considering their effects on only the slow students in your classes? Yes_____ No_____

4. If you answered yes, identify the component, check whether it was more or less effective for slow students than for the average in attaining the given learning objective, and identify the learning objective on the form below?

Component	More Effective	Less Effective	Objective

ACTIVITIES OF TEACHER AIDES

Rank the following possible activities of teacher aides in the order of their importance with regard to their contribution to the improvement of student academic achievement. Use a scale of 1 to 10, with 1 indicating the most important activity and 10 the least. If the activity was never performed, or made no contribution, enter a 0. Then rank the same activities for their contribution to the improvement of student attitude.

ACTIVITIES	CONTRIBUTION TO: ACADEMIC ACHIEVEMENT	ATTITUDE CHANGE
1. Assist students with problems in reading or humanities		
2. Assist students with problems in arithmetic		
3. Help students during gaming/ simulation activity		
4. Make visits to students' homes		
5. Correcting papers		
6. Contact parents concerning student problems		
7. Assist in general housekeeping in the classroom		
8. Help students with personal problems outside of class		
9. Handle discipline problems in the classroom		
10. Other (Explain on line below)		

PREVIOUS TEACHING EXPERIENCE

(This page to be filled out by teachers only.)

1. How many years have you taught in Woodrow Wilson? _____

2. Describe your previous teaching experience, classifying your experience on the basis of the academic ability of the average student in the classes you taught (above average, average, below average), the city or town, the grade, and the number of years taught. For example, if you taught an eighth grade honors class for three years and an eighth grade "Y" (or average) class for the same three years in the same school, please show each experience separately.

	AVERAGE ACADEMIC ABILITY	CITY OR TOWN	GRADE	NUMBER OF YEARS TAUGHT
a.				
b.				
c.				
d.				
e.				
f.				
g.				
h.				
i.				
j.				

3. Have you taught in a Title I program before? (Check if yes)

   Yes, in Woodrow Wilson _____
   Yes, in another school _____

4. If you taught in a Title I program in another school, on which of the lines in question 2 have you listed that school? _____

5. Do you speak Spanish? (Check one)

   Yes, fluently _____ I know a few words _____

   Fairly well _____ I have no knowledge of Spanish _____

PREVIOUS EXPERIENCE AS A TEACHER AIDE

(This page to be filled out by teacher aides only.)

1. List the schools at which you have been a teacher aide and the number of semesters you have worked at each school.

	SCHOOL	NUMBER OF SEMESTERS
a.		
b.		
c.		
d.		
e.		

Appendix C

STUDENT QUESTIONNAIRE

STUDENT NAME:_____ TEACHER NUMBER:_____

DIRECTIONS: Below is a list of some of the activities that you have been in this last semester. Read the list and then answer the questions by writing the number of the item on the list that answers the question.

1. Reading class
2. Arithmetic class
3. Humanities class
4. R-3 class
5. Short field trips
6. Intensive involvement

QUESTIONS:

1. Which of the things on the list did you enjoy the most? _____
2. Which did you enjoy the least? _____
3. Which of the things on the list was the most help to you in your school work? _____
4. Which was the least help to you in your school work? _____

Appendix D

SESSIONS USING THE THREE MODES OF INTERACTION

```
Use file 284 (K9490).
Roger.
Recall item 25 (K9490).
Done.
Do part 30.


Do you want an introduction to this routine? Yes=1,No=2. = 2


Do you want to 'analyze' the program over time or
'compare' alternative programs for a given period?
Analyze=1, Compare=2. = 1


Mode = 1

Do you want to have a table displayed? Yes=1,No=2. = 2
Do you want to change a value in a table? Yes=1,No=2. = 1
Table Number = 1

Column Number  = 0
Row Number  = 1
New Value = 500

Do you want to have a table displayed? Yes=1,No=2. = 2
Do you want to change a value in a table? Yes=1,No=2. = 2
Do you want the results printed out? Yes=1, No=2. = 2
Do you want to create a new year? Yes=1, No=2. = 1

Do you want to have a table displayed? Yes=1,No=2. = 2
Do you want to change a value in a table? Yes=1,No=2. = 1
Table Number = 3

Column Number  = 3
Row Number  = 1
New Value = 12000

Do you want to have a table displayed? Yes=1,No=2. = 2
Do you want to change a value in a table? Yes=1,No=2. = 2
Do you want the results printed out? Yes=1, No=2. = 1
```

Fig. 28--Mode 1

```
Use file 284 (K9490).
Roger.
Recall item 25 (K9490).
Done.
Do part 30.


Do you want an introduction to this routine? Yes=1,No=2. = 2


Do you want to 'analyze' ONE PROGRAM OVER TIME OR
'compare' alternative programs for a given period?
Analyze=1, Compare=2. = 1


Mode = 2

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 1

Column Number  = 0
Row Number  = 1
New Value = 500

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 4

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 2
Table Number = 3

Column Number  = 3
Row Number  = 1
New Value = 12000

Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5) = 3
```

Fig. 29--Mode 2

```
Use file 284 (K9490).
Roger.
Recall item 25 (K9490).
Done.
Do part 30.


Do you want an introduction to this routine? Yes=1,No=2. = 2


Do you want to 'analyze' one program over time or
'compare' alternative programs for a given period?
Analyze=1, Compare=2. = 1


Mode = 3

Action = 2
Table Number = 1

Column Number  = 0
Row Number  = 1
New Value = 500

Action = 4

Action = 2
Table Number = 3

Column Number  = 3
Row Number  = 1
New Value = 12000

Action = 3
```

Fig. 30--Mode 3

Appendix E

R-3 COST-MODEL COMPUTER PROGRAM

```
Recall item 1 (K9490).
Done.
Type all.

10.1 Set w(1,1,i)=350.
10.2 Set w(1,3,i)=20.
10.3 Set w(1,4,i)=30.
10.4 Set w(1,7,i)=1.0.
10.5 Set w(1,8,i)=.5.
10.6 Set w(1,9,i)=.5.

11.10 Set w(1,2,1)=10.
11.12 Set w(1,2,2)=9.
11.13 Set w(1,2,3)=8.
11.14 Set w(1,2,4)=3.
11.152 Set w(1,5,1)=0.
11.16 Set w(1,5,2)=1.
11.17 Set w(1,5,3)=1.
11.172 Set w(1,5,4)=0.
11.18 Set w(1,6,1)=1.
11.182 Set w(1,6,2)=0.
11.184 Set w(1,6,3)=0.
11.19 Set w(1,6,4)=1.
11.20 Set w(1,10,1)=15.
11.21 Set w(1,10,2)=10.
11.22 Set w(1,10,3)=10.
11.23 Set w(1,10,4)=8.

12.10 Set w(2,1,1)=4.
12.11 Set w(2,1,2)=2.
12.12 Set w(2,1,3)=2.
12.13 Set w(2,2,1)=1.
12.14 Set w(2,2,2)=4.
12.15 Set w(2,2,3)=.5.
12.16 Do step 12.17 for i=1(1)3.
12.17 Set w(2,3,i)=350.
12.18 Set w(2,4,1)=.03.
12.19 Set w(2,4,2)=.05.
12.20 Set w(2,4,3)=.03.
12.21 Set w(2,5,1)=0.
12.22 Set w(2,5,2)=2.
12.23 Set w(2,5,3)=1.
12.24 Set w(2,6,1)=0.
12.25 Set w(2,6,2)=0.
12.26 Set w(2,6,3)=250.
12.27 Set w(2,7,1)=0.
12.28 Set w(2,7,2)=1.00.
12.29 Set w(2,7,3)=1.25.
12.30 Set w(2,8,1)=0.
12.31 Set w(2,8,2)=.50.
12.32 Set w(2,8,3)=0.
12.33 Set w(2,9,1)=.25.
12.34 Set w(2,9,2)=.30.
12.35 Set w(2,9,3)=0.
```

```
12.36 Set w(2,10,1)=50.
12.37 Set w(2,10,2)=200.
12.375 Set w(2,10,3)=0.
12.38 Set w(2,11,1)=60.
12.39 Set w(2,11,2)=80.
12.40 Set w(2,11,3)=0.
12.401 Do step 12.402 for i=1(1)3.
12.402 Set w(2,12,i)=50.
12.403 Set w(2,13,1)=35.
12.404 Set w(2,13,2)=45.
12.405 Set w(2,13,3)=0.
12.41 Set w(3,1,1)=30.
12.42 Set w(3,1,2)=1.
12.425 Set w(3,1,3)=11000.
12.43 Set w(3,2,1)=15.
12.44 Set w(3,2,2)=0.
12.445 Set w(3,2,3)=7500.
12.45 Set w(3,3,1)=15.
12.46 Set w(3,3,2)=0.
12.465 Set w(3,3,3)=4000.
12.47 Set w(4,1,1)=12.
12.48 Set w(4,1,2)=7.
12.49 Set w(4,2,1)=30.
12.50 Set w(4,2,2)=30.
12.51 Set w(4,3,1)=100.
12.52 Set w(4,3,2)=200.
12.53 Set w(4,4,1)=5000.
12.54 Set w(4,4,2)=7000.
12.55 Set w(4,5,1)=500.
12.56 Set w(4,5,2)=1000.
12.57 Set w(4,6,1)=2000.
12.58 Set w(4,6,2)=3000.
12.59 Set d(0,5)=142000.
```

```
Recall item 3 (K9490).
Done.
Type all.

75.135 Line.
75.14 Demand j as "Column Number ".
75.16 Demand i as "Row Number ".
75.161 Set k=1 if i=0.
75.162 Set l=1 if j=0.
75.163 Set k=i if i≠0.
75.164 Set l=j if j≠0.
75.17 Demand w(n,k,l) as "New Value".
75.171 Done if i≠0 and j≠0.
75.1715 To step 75.175 if j≠0.
75.172 Do step 75.1745 for m=1(1)4 if n=1.
75.1725 Do step 75.1745 for m=1(1)3 if n=2.
75.173 Do step 75.1745 for m=1(1)3 if n=3.
75.1735 Do step 75.1745 for m=1(1)2 if n=4.
75.174 To step 75.175.
75.1745 Set w(n,k,m)=w(n,k,l).
75.175 Done if i≠0.
75.1755 Do step 75.178 for m=1(1)10 if n=1.
75.176 Do step 75.178 for m=1(1)13 if n=2.
75.1765 Do step 75.178 for m=1(1)3 if n=3.
75.177 Do step 75.178 for m=1(1)6 if n=4.
75.1775 Done.
75.178 Set w(n,m,l)=w(n,k,l).
```

```
Recall item 4 (K9490).
Done.
Type all.

20.1 Demand n as "Table Number".
20.15 Recall item 23 (K9490).
20.2 Do part 9 if n=1.
20.3 Do part 13 if n=2.
20.4 Do part 14 if n=3.
20.5 Do part 15 if n=4.
20.6 Delete part 9,part 13,part 14,part 15.
```

```
Delete all.
Recall item 5 (K9490).
Done.
Type all.

21.10 Recall item 9 (K9490).
21.12 Do part 62.
21.13 Delete part 62,part 67,part 68,part 65,part 69.
21.135 Delete all forms.
21.14 Type _,_.
21.15 Type "Do you want a summary of the costs of alternative programs by".
21.16 Demand P as "program component and cost element? Yes=1, No=2.".
21.165 Done if P=2.
21.167 Recall item 7 (K9490).
21.17 Do part 63.
21.18 Delete part 63, part 64, part 66, all forms,a,b,c,d,e.
```

```
Delete all.
Recall item 6 (K9490).
Done.
Type all.

22.10 Set N=N+1.
22.103 Recall item 24 (K9490).
22.105 Do part 6.
22.106 Do part 7.
22.107 Delete part 6,part 7,part 8,part 2.
22.11 Done if N=1.
22.113 Done if R(20)=1.
22.12 Type _,_.
22.13 Type  "Do you want the base case values restored to the input tables".
22.14 Type "or do you want the tables to retain the current alternative".
22.15 Demand P as "program values? Restore=1, Retain=2.".
22.16 Done if P=2.
22.17 Recall item 24 (K9490).
22.18 Do part 2.
22.19 Delete part 2,part 6,part 7,part 8.
```

```
Delete all.
Recall item 7 (K0490).
Done.
Type all.

63.05 Page.
63.10 Type form 65,_,_,form 56,_,form 66.
63.16 Set k=1.
63.17 Do part 64.
63.18 Type _,form 69.
63.19 Set k=2.
63.2 Do part 64.
63.21 Type _,form 72.
63.22 Set k=3.
63.23 Do part 64.
63.24 Type _, form 73.
63.25 Set k=4.
63.26 Do part 64.
63.27 Type _,form 74.
63.28 Set k=5.
63.29 Do part 64.
63.3 Type _,form 75.
63.31 Set k=6.
63.32 Do part 64.

64.10 Set A=a(0,1,k).
64.11 Set B=a(0,2,k).
64.12 Set C=a(0,3,k).
64.13 Set D=a(0,4,k).
64.14 Set E=a(0,5,k).
64.15 Set F=a(0,6,k).
64.16 Set G=a(0,7,k).
64.17 Set H=a(0,8,k).
64.18 Type A,B,C,D,E,F,G,H in form 67 if R(20)=2.
64.182 Type A,B,C,D,E,F,G,H in form 670 if R(20)=1.
64.19 Do part 66 for i=1(1)N if N>0.

66.10 Set A=a(i,1,k).
66.11 Set B=a(i,2,k).
66.12 Set C=a(i,3,k).
66.13 Set D=a(i,4,k).
66.14 Set E=a(i,5,k).
66.15 Set F=a(i,6,k).
66.16 Set G=a(i,7,k).
66.17 Set H=a(i,8,k).
66.18 Type i,A,B,C,D,E,F,G,H in form 68 if R(20)=2.
66.19 Type i,A,B,C,D,E,F,G,H in form 680 if R(20)=1.

Form 56:
                    Read    Math     Hum     R-3      FT       II       PI    Tot

Form 65:
                          TABLE 5:  COST ELEMENT, PROGRAM COMPONENT SUMMARY
```

Form 66:
*SALARIES

Form 67:
Base Case ——— ——— ——— ——— ——— ——— ——— ———

Form 68:
Alternative _ ——— ——— ——— ——— ——— ——— ——— ———

Form 69:
*MATERIALS

Form 72:
*EQUIPMENT MT.

Form 73:
*INSERVICE TRG.

Form 74:
*FOOD + LODGING

Form 75:
*TRANSPORTATION

Form 670:
Base Year (0) ——— ——— ——— ——— ——— ——— ——— ———

Form 680:
Year __ ——— ——— ——— ——— ——— ——— ——— ———

```
Delete all.
Recall item 8 (K9490).
Done.
Type all.

50.10 Set a(N,i,2)=w(1,10,i)•w(1,1,i).
50.11 Set p(i)=w(1,1,i)/w(1,3,i).
50.112 Set R(i)=w(1,1,i)/w(1,4,i).
50.113 Set R(i)=ip(R(i)).
50.12 Do part 52 if fp(p(i))>0.
50.13 Set h(i)=p(i)•w(1,2,i).
50.135 Set R(i)=R(i)•w(1,2,i).
50.14 Set q(i)=h(i)•w(1,5,i)/w(4,2,2)+h(i)•w(1,6,i)/w(4,2,2).
50.15 Set Z(1)=Z(1)+h(i) if w(1,5,i)>0.
50.16 Set Z(2) = Z(2)+h(i) if w(1,6,i)>0.
50.19 Do part 51 for l=1(1)3.

51.10 Set v(i,l)=h(i)•w(1,l+6,i).
51.11 Set S(i,l)=R(i)•w(1,l+6,i).
51.13 Set M(l)=M(l)+v(i,l).
51.14 Set O(l)=O(l)+S(i,l).

52.10 Set Y=fp(p(i))•w(1,3,i).
52.11 Set p(i)=ip(p(i))+1 if Y>p(i)•(w(1,4,i)-w(1,3,i)).
52.12 Set p(i)=ip(p(i)) if Y≤p(i)•(w(1,4,i)-w(1,3,i)).
```

```
Delete all.
Recall item 9 (K9490).#
Done.
Type all.

62.
62.10 Page.
62.11 Type form 44,_,_,form 45, form 46,_.
62.12 Type d(0,1),d(0,2),d(0,3),d(0,5),d(0,4) in form 470 if R(20)=1.
62.17 Type d(0,1),d(0,2),d(0,3),d(0,5),d(0,4) in form 47 if R(20)=2.
62.19 Do part 69 for i=1(1)N if N>0.
62.20 Type _,_,_,_,form 49,_,_,form 50,form 51,_.
62.30 Set A=b(0,1).
62.31 Set B=b(0,2).
62.32 Set C=b(0,3).
62.33 Set D=b(0,4).
62.34 Set E=b(0,5).
62.35 Set F=b(0,6).
62.36 Set G=b(0,7).
62.37 Set H=b(0,8).
62.38 Set I=b(0,9).
62.39 Set J=b(0,10).
62.40 Set K=b(0,11).
62.405 Type A,B,C,D,E,F,G,H,I,J in form 520 if R(20)=1.
62.41 Type A,B,C,D,E,F,G,H,I,J in form 52 if R(20)=2.
62.42 Do part 67 for i=1(1)N if N>0.
62.43 Type _,_,_,_,form 54,_,_,form 56,_.
62.44 To step 62.49 if R(20)=2.
62.45 Type c(0,1),c(0,2),c(0,3),c(0,4),c(0,5),c(0,6),c(0,7),c(0,8) in form 99.
62.46 To step 62.51.
62.49 Type c(0,1),c(0,2),c(0,3),c(0,4),c(0,5),c(0,6),c(0,7),c(0,8) in form 57.
62.51 Do part 68 for i=1(1)N if N>0.
62.52 Type _,_,_,_,form 59,_,_,form 60,form 61,form 62.
62.53 Line.
62.72 Set A=e(0,1).
62.73 Set B=e(0,2).
62.74 Set C=e(0,3).
62.75 Set D=e(0,4).
62.76 Set E=e(0,5).
62.77 Set F=e(0,6).
62.78 Set G=e(0,7).
62.79 Set H=e(0,8).
62.8 Set I=e(0,9).
62.81 Type A,B,C,D,E,F,G,H,I in form 63 if R(20)=2.
62.812 Type A,B,C,D,E,F,G,H,I in form 630 if R(20)=1.
62.82 Do part 65 for i=1(1)N if N>0.

65.10 Set A=e(i,1).
65.11 Set B=e(i,2).
65.12 Set C=e(i,3).
65.13  Set D=e(i,4).
65.14 Set E=e(i,5).
65.15 Set F=e(i,6).
65.16 Set G=e(i,7).
```

```
65.17 Set H=e(i,8).
65.19 Set I=e(i,9).
65.20 Type i,A,B,C,D,E,F,G,H,I in form 64 if R(20)=2.
65.21 Type i,A,B,C,D,E,F,G,H,I in form 640 if R(20)=1.

67.10 Set A=b(i,1).
67.11 Set B=b(i,2).
67.12 Set C=b(i,3).
67.13 Set D=b(i,4).
67.14 Set E=b(i,5).
67.15 Set F=b(i,6).
67.16 Set G=b(i,7).
67.17 Set H=b(i,8).
67.18 Set I=b(i,9).
67.19 Set J=b(i,10).
67.20 Set K=b(i,11).
67.21 Type i,A,B,C,D,E,F,G,H,I,J in form 53 if R(20)=2.
67.22 Type i,A,B,C,D,E,F,G,H,I,J in form 530 if R(20)=1.

68.10 Set A=c(i,1).
68.11 Set B=c(i,2).
68.12 Set C=c(i,3).
68.13 Set D=c(i,4).
68.14 Set E=c(i,5).
68.15 Set F=c(i,6).
68.16 Set G=c(i,7).
68.17 Set H=c(i,8).
68.18 Type i,A,B,C,D,E,F,G,H in form 58 if R(20)=2.
68.19 Type i,A,B,C,D,E,F,G,H in form 580 if R(20)=1.

69.10 Set A=d(i,1).
69.11 Set B=d(i,2).
69.12 Set C=d(i,3).
69.13 Set D=d(i,4).
69.14 Type i,A,B,C,d(0,5),D in form 48 if R(20)=2.
69.15 Type i,A,B,C,d(0,5),D in form 480 if R(20)=1.

Form 44:
                                        TABLE 1

Form 45:
                    Total      Cost/     Inc.Cost/     Program     Additional

Form 46:
                     Cost      Student     Student     Mgmt.Cost      Capital

Form 47:
Base Case      _____._____ _____._____ _____._____ _____._____ _____._____

Form 48:
Alternative  __ _____._____ _____._____ _____._____ _____._____ _____._____

Form 49:
                        TABLE 2:  COST ELEMENT SUMMARY
```

Form 50:

Form 51:

Form 52:
Base Case

Form 53:
Alternative

Form 54:

Form 56:

Form 57:
Base Case

Form 58:
Alternative

Form 59:

Form 60:

Form 61:

Form 62:

Form 63:
Base Case

Form 64:
Alternative

Form 99:
Base Year (0)

Form 470:
Base Year (0)

Form 480:
Year

Form 520:
Base Year (0)

	Sal	Matl	Mt. Equ	Ins. Trg.	Fd.+ Lodg	Tran	Tot	Cap Rms	Cap Equ	Cap Rem

TABLE 3: PROGRAM COMPONENT SUMMARY

	Read	Math	Hum	R-3	FT	II	PI	Tot

TABLE 4: PHYSICAL DATA

	Teachers			Classrooms					
	Reg	Spec	Aide	No.Req.		No.Rem.		No.Add.	
				Reg	Spec	Reg	Spec	Reg	Spec

Form 530:
Year __ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

Form 580:
Year __ ____ ____ ____ ____ ____ ____ ____ ____

Form 630:
Base Year (0) __ ____ ____ ____ ____ ____ ____ ____ ____

Form 640:
Year __ ____ ____ ____ ____ ____ ____ ____ ____ ____

```
Delete all.
Recall item 10 (K9490).=
Done.
Type all.

24.10 Demand n as "Table Number".
24.105 Recall item 3 (K9490).
24.11 Do part 75.
24.12 Delete part 75.
```

```
Delete all.
Recall item 11 (K9490).
Done.
Type all.

70.10 Page.
70.11 Type form 1.
70.12 Line.
70.13 Line.
70.14 Type form 2.
70.15 Line.
70.16 Type w(1,1,1), w(1,1,2), w(1,1,3), w(1,1,4) in form 3.
70.17 Type w(1,2,1), w(1,2,2), w(1,2,3), w(1,2,4) in form 4.
70.18 Type form 5.
70.19 Type w(1,3,1), w(1,3,2), w(1,3,3), w(1,3,4) in form 6.
70.20 Type w(1,4,1), w(1,4,2), w(1,4,3), w(1,4,4) in form 7.
70.21 Type form 8.
70.22 Type w(1,5,1), w(1,5,2), w(1,5,3), w(1,5,4) in form 9.
70.23 Type w(1,6,1), w(1,6,2), w(1,6,3), w(1,6,4) in form 10.
70.24 Type form 11.
70.25 Type w(1,7,1), w(1,7,2), w(1,7,3), w(1,7,4) in form 12.
70.26 Type w(1,8,1), w(1,8,2), w(1,8,3), w(1,8,4) in form 13.
70.27 Type w(1,9,1), w(1,9,2), w(1,9,3), w(1,9,4) in form 14.
70.28 Type w(1,10,1), w(1,10,2), w(1,10,3), w(1,10,4) in form 15.

Form 1:

                    TABLE 1:  INPUTS PER SUBJECT

Form 2:
                        1. Read     2. Math     3. Hum      4. R-3

Form 3:
1. Enrollment           _____       _____       _____       _____

Form 4:
2. Classhrs/wk/stud     _____       _____       _____       _____

Form 5:
   Class Size

Form 6:
3. Program              _____       _____       _____       _____

Form 7:
4. District             _____       _____       _____       _____

Form 8:
   Classroom Req.

Form 9:
5. Regular              _____       _____       _____       _____

Form 10:
6. Special              _____       _____       _____       _____
```

Form 11:
Teacher Manhrs/Classhr

Form 12:
7. Regular ___.___ ___.___ ___.___ ___.___

Form 13:
8. Specialists ___.___ ___.___ ___.___ ___.___

Form 14:
9. Aides ___.___ ___.___ ___.___ ___.___

Form 15:
10.$Materials/yr/stud _____ _____ _____ _____

```
Delete all.
Recall item 12 (K9490).
Done.
Type all.

80.10 Page.
80.11 Type form 16.
80.12 Line.
80.13 Line.
80.14 Type form 17.
80.15 Line.
80.16 Type w(2,1,1), w(2,1,2), w(2,1,3) in form 18.
80.17 Type w(2,2,1), w(2,2,2), w(2,2,3) in form 19.
80.18 Type w(2,3,1), w(2,3,2), w(2,3,3) in form 20.
80.19 Type w(2,4,1), w(2,4,2), w(2,4,3) in form 21.
80.20 Type w(2,5,1), w(2,5,2), w(2,5,3) in form 70.
80.21 Type w(2,6,1), w(2,6,2), w(2,6,3) in form 71.
80.22 Type w(2,7,1), w(2,7,2), w(2,7,3) in form 22.
80.23 Type w(2,8,1), w(2,8,2), w(2,8,3) in form 23.
80.24 Type w(2,9,1), w(2,9,2), w(2,9,3) in form 24.
80.25 Type w(2,10,1), w(2,10,2), w(2,10,3) in form 26.
80.26 Type w(2,11,1), w(2,11,2), w(2,11,3) in form 25.
80.27 Type form 27.
80.28 Type w(2,12,1), w(2,12,2), w(2,12,3) in form 28.
80.29 Type w(2,13,1), w(2,13,2), w(2,13,3) in form 29.
```

Form 16:

TABLE 2: INPUTS PER ACTIVITY

Form 17:

	1. Field Tr.	2. Inten.Inv.	3. Par.Inv.
Form 18: 1. Number/year	_____	_____	_____
Form 19: 2. Length in days	___._	___._	___._
Form 20: 3. Enrollment	_____	_____	_____
Form 21: 4. Teachers/student	___._	___._	___._
Form 22: 7. $Food/person/day	___._	___._	___._
Form 23: 8. $Lodge/person/day	___._	___._	___._
Form 24: 9. $/mile/bus	___._	___._	___._
Form 25: 11. Max bus capacity	_____	_____	_____

Form 26:			
10. Avg. mileage	_____	_____	_____
Form 27:			
Salary/Add.Part./Day			
Form 28:			
12. Consultants	_____	_____	_____
Form 29:			
13. Bus drivers	_____	_____	_____
Form 70:			
5. No. consultants	_____	_____	_____
Form 71:			
6. No. add. participants	_____	_____	_____

```
Delete all.
Recall item 13 (K9490).
Done.
Type all.

90.10 Page.
90.11 Type form 30,_,_,form 31,form 500,_.
90.16 Do part 91 for i=1(1)3.
90.19 Set n=3.

91.10 Type w(3,i,1),w(3,i,2),w(3,i,3) in form 31+i.
```

Form 30:

TABLE 3: INPUTS PER TEACHER

Form 31:

	1. Total Manhrs.	2. Ins.Trg.	3. Annual
Form 32:			
1. Regular	_____	_____	_____
Form 33:			
2. Specialist	_____	_____	_____
Form 34:			
3. Aide	_____	_____	_____

Form 500:

Avail./Week	Hrs./Week	Salary

```
Delete all.
Recall item 14 (K9490).
Done.
Type all.

100.10 Page.
100.11 Type form 35,_,_,form 36,_.
100.16 Do part 101 for i=1(1)6.

101.10 Type w(4,i,1),w(4,i,2) in form 36+i.
```

Form 35:

TABLE 4: INPUTS PER CLASSROOM

Form 36:

	1. Regular	2. Special
Form 37: 1. Number avail.	_____	_____
Form 38: 2. No.hours avail/wk	_____	_____
Form 39: 3. $EquipMt/room/year	_____	_____
Form 40: 4. Cost/add.room	_____	_____
Form 41: 5. EqCost/add/room	_____	_____
Form 42: 6. Cost to remodel	_____	_____

```
Delete all.
Recall item 15 (K9490).
Done.
Type all.

53.10 Set T(1)=M(1)/(w(3,1,1)-w(3,1,2)) if (w(3,1,1)-w(3,1,2))>0.
53.101 Set T(1)=0 if w(3,1,1)=0.
53.11 Set T(1)=ip(T(1))+1 if fp(T(1))>0.
53.12 Set e(N,1)=T(1).
53.13 Set R(1)=O(1)/w(3,1,1) if w(3,1,1)>0.
53.14 Set R(1)=0 if w(3,1,1)=0.
53.15 Set R(1)=ip(R(1))+1 if fp(R(1))>0.
```

```
Delete all.
Recall item 16 (K9490).
Done.
Type all.

54.10 Set Z(3)=Z(1)/w(4,2,1).
54.105 Set Z(3)=ip(Z(3))+1 if fp(Z(3))>0.
54.11 Set Z(4)=Z(2)/w(4,2,2).
54.115 Set Z(4)=ip(Z(4))+1 if fp(Z(4))>0.
54.116 Set e(N,4)=Z(3).
54.117 Set e(N,5)=Z(4).
54.12 Do part  58 for i=1(1)4.
54.15 Set U=Z(3)•w(4,3,1).
54.16 Set W=Z(4)•w(4,3,2).
54.17 Set a(N,8,3)=U+W.
54.19 Do part 55 for i=1(1)4.

55.10 Set a(N,i,3)=h(i)/Z(1)•U if w(1,5,i)>0.
55.11 Set a(N,i,3)=a(N,i,3)+h(i)/Z(2)•W if w(1,6,i)>0.
55.12 Set A=w(3,1,2)/w(3,1,1) if w(3,1,1)>0.
55.13 Set A=0 if w(3,1,1)≤0.
55.14 Set B=w(3,2,2)/w(3,2,1) if w(3,2,1)>0.
55.15 Set B=0 if w(3,2,1)≤0.
55.16 Set C=w(3,3,2)/w(3,3,1) if w(3,3,1)>0.
55.17 Set C=0 if w(3,3,1)≤0.
55.18 Set a(N,i,4)=A•(v(i,1)•w(3,1,3)/M(1))•T(1).
55.19 Set a(N,i,4)=a(N,i,4)+B•(v(i,2)•w(3,2,3)/M(2))•T(2).
55.20 Set a(N,i,4)=a(N,i,4)+C•(v(i,3)•w(3,3,3)/M(3))•T(3).

58.10 Set A=(w(3,1,1)-w(3,1,2))/w(3,1,1) if w(3,1,1)>0.
58.11 Set A=0 if w(3,1,1)≤0.
58.12 Set B=(w(3,2,1)-w(3,2,2))/w(3,2,1) if w(3,2,1)>0.
58.13 Set B=0 if w(3,2,1)≤0.
58.14 Set C=(w(3,3,1)-w(3,3,2))/w(3,3,1) if w(3,3,1)>0.
58.15 Set C=0 if w(3,3,1)≤0.
58.16 Set a(N,i,1)=A•(v(i,1)•w(3,1,3)/M(1))•(T(1)-R(1)).
58.17 Set a(N,i,1)=a(N,i,1)+B•(v(i,2)•w(3,2,3)/M(2))•T(2).
58.18 Set a(N,i,1)=a(N,i,1)+C•(v(i,3)•w(3,3,3)/M(3))•T(3).
```

```
Delete all.
Recall item 17 (K9490).
Done.
Type all.

56.10 Set V(1)=Z(3)-w(4,1,1).
56.105 Set V(2)=Z(4)-w(4,1,2).
56.12 Set e(N,8)=V(1) if V(1)≥0 and V(2)≥0.
56.13 Set e(N,9)=V(2) if V(1)≥0 and V(2)≥0.
56.14 To step 56.25 if V(1)≥0 and V(2)≥0.
56.15 Set W=V(1)+V(2).
56.16 To step 56.22 if W≤0.
56.17 Set e(N,8)=W if V(1)>0 and V(2)<0.
56.18 Set e(N,7)=|V(2)| if V(1)≥0 and V(2)≤0.
56.19 Set e(N,9)=W if V(1)<0 and V(2)>0.
56.20 Set e(N,6)=|V(1)| if V(1)≤0 and V(2)≥0.
56.21 To step 56.24.
56.22 Set e(N,7)=V(1) if V(1)>0 and V(2)<0.
56.23 Set e(N,6)=V(2) if V(1)<0 and V(2)>0.
56.24 Set b(N,10)=e(N,6)•w(4,6,1)+e(N,7)•w(4,6,2).
56.25 Set b(N,8)=e(N,8)•w(4,4,1)+e(N,9)•w(4,4,2).
56.26 Do step 56.27 for i=1(1)2.
56.27 Set X(i)=V(i)•w(4,5,i) if V(i)>0.
56.28 Set b(N,9)=X(1)+X(2).
56.29 Set w(4,1,1)=w(4,1,1)-e(N,6)+e(N,7)+e(N,8).
56.30 Set w(4,1,2)=w(4,1,2)-e(N,7)+e(N,6)+e(N,9).



Delete all.
Recall item 18 (K9490).
Done.
Type all.

57.10 Set g(i)=w(2,3,i)•w(2,4,i).
57.11 Set g(i)=ip(g(i))+1 if fp(g(i))>0.
57.12 Set f(i)=(w(2,3,i)+g(i)+w(2,5,i)+w(2,6,i))/w(2,11,i) if w(2,11,i)>0.
57.125 Set f(i)=0 if w(2,11,i)=0.
57.13 Set f(i)=ip(f(i))+1 if fp(f(i))>0.
57.14 Set a(N,i+4,6)=ip(f(i)•w(2,1,i)•w(2,10,i)•w(2,9,i)).
57.145 Set w(2,2,i)=ip(w(2,2,i))+1 if fp(w(2,2,i))>0.
57.15 Set a(N,i+4,5)=w(2,3,i)+g(i)+f(i)+w(2,5,i)+w(2,6,i).
57.16 Set a(N,i+4,5)=ip(a(N,i+4,5)•(w(2,7,i)+w(2,8,i))•w(2,2,i)•w(2,1,i)).
57.17 Set a(N,i+4,1)=f(i)•w(2,13,i)•w(2,2,i)•w(2,1,i).
57.18 Set a(N,i+4,1)=a(N,i+4,1)+w(2,5,i)•w(2,12,i)•w(2,1,i)•w(2,2,i).
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Delete all.
Recall item  19 (K9490).
Done.
Type all.

59.10 Set a(N,i,j)=a(N,i,j)/100 if a(N,i,j)>0.

60.10 Do step 60.11 for k=1(1)6.
60.11 Set a(N,8,k)=sum(j=1(1)7:a(N,j,k)).
60.12 Do step 60.13 for k=1(1)6.
60.13 Set b(N,k)=a(N,8,k).
60.14 Set b(N,7)=sum(k=1(1)6:b(N,k)).
60.15 Set d(N,1)=b(N,7).
60.16 Set b(N,11)=sum(k=8(1)10:b(N,k)).
60.17 Set d(N,4)=b(N,11).
60.18 Set D=max(k=1(1)4:w(1,1,k)).
60.19 Set d(N,2)=d(N,1)/D.
60.20 To step 60.22 if N=0.
60.21 Set d(N,3)=d(N,2)-d(N-1,2).
60.22 Do step 60.23 for j=1(1)7.
60.23 Set c(N,j)=sum(k=1(1)6:a(N,j,k)).
60.24 Set c(N,8)=sum(j=1(1)7:c(N,j)).
60.25 Do step 60.26 for i=1(1)11.
60.26 Set b(N,i)=b(N,i)/100 if b(N,i)>0.
60.27 Do part 77 for i=1(1)8.
60.29 Do part  61 for i=1(1)8.

61.10 Do part 59 for j=1(1)6.

77.10 Set c(N,i)=c(N,i)/100 if c(N,i)>0.
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Delete all.
Recall item 20 (K9490).
Done.
Type all.

40.1 Demand P as "Do you want to have a table displayed? Yes=1,No=2.".
40.2 Set Q=1 if P=1.
40.3 Done if P=1.
40.4 Demand P as "Do you want to change a value in a table? Yes=1,No=2.".
40.41 Set Q=2 if P=1.
40.42 Done if P=1.
40.5 Demand P as "Do you want the results printed out? Yes=1, No=2.".
40.51 Set Q=3 if P=1.
40.52 Done if P=1.
40.54 To step 40.605 if R(20)=1.
40.6 Demand P as "Do you want to create a new alternative? Yes=1,No=2.".
40.603 To step 40.61.
40.605 Demand P as "Do you want to create a new year? Yes=1, No=2.".
40.61 Set Q=4 if P=1.
40.62 Done if P=1.
40.7 Set Q=5.

41.05 To step 41.3 if R(20)=1.
41.1 Demand Q as "Action(Display=1,Change=2,Output=3,Alternative=4,Quit=5)".
41.2 Done if R(20)=2.
41.3 Demand Q as "Action(Display=1,Change=2,Output=3,NewYear=4,Quit=5)".
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Delete all.
Recall item 21 (K9490).
Done.
Type all.

5.10 Type "     This routine calculates the costs for the current San Jose".
5.11 Type "R-3 program (the base case/the base year) and alternative".
5.12 Type "programs or future years planned by you.  You will be asked".
5.13 Type "to indicate whether you wish to compare alternative programs".
5.131 Type "for a given period or to analyze one program over time.".
5.132 Type "     There are 5 actions you may take in manipulating the".
5.133 Type "routine:".
5.14 Line.
5.15 Type "     1.  Display a table;                          (Display)".
5.16 Type "     2.  Change a value;                          (Change) ".
5.17 Type "     3.  Output results;                          (Output)".
5.18 Type "     4.  Create a new alternative/new year;(Alternative)(NewYear)".
5.19 Type "     5.  Quit.                                    (Quit)".
5.195 Line.
5.20 Type "The first two actions require short explanations. 'Display'".
5.21 Type "will cause the routine to print one of 4 input tables:".
5.22 Line.
5.23 Type "     Table 1:  Inputs Per Subject".
5.24 Type "     Table 2:  Inputs Per Activity".
5.25 Type "     Table 3:  Inputs Per Teacher".
5.26 Type "     Table 4:  Inputs Per Classroom".
5.27 Line.
5.28 Type "You specific which table by typing the table number when it".
5.29 Type "is requested.  As you 'change' values in these tables you may".
5.30 Type "wish to have the tables displayed again with the new values.".
5.31 Type "     A value in one of these tables may be changed by typing".
5.32 Type "'2' for action and then the table number, column number and row".
5.33 Type "number associated with the value.  If all values in a column are".
5.34 Type "to be changed to the same number, type '0' when the row number is".
5.35 Type "requested.  Similarly, to change all values in a row, type '0'".
5.36 Type "when the column number is requested.".
5.37 Type "     There are 3 modes of interaction available:".
5.375 Line.
5.38 Type "     Mode 1:  Queries by sentence; requires yes/no response.".
5.39 Type "     Mode 2:  Queries by phrase; requires code response.".
5.40 Type "     Mode 3:  Queries by word; requires code response.".
5.405 Line.
5.41 Type "It is recommended that Version 1 is used the first time through".
5.42 Type "the routine.  Now let's get started.".
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Delete all.
Recall item 22 (K9490).
Done.
Type all.

4.11 Recall item 2 (K9490) if N>0.
4.111 To step 4.115 if s(1)=4 and Q≠3.
4.112 Recall item 24 (K9490).
4.113 Do part 6.
4.114 Delete part 2,part 6,part 7,part 8.
4.115 Recall item 8 (K9490).
4.12 Do part 50 for i=1(1)4.
4.122 Delete part 50,part 51,part 52.
4.125 Recall item 15 (K9490).
4.13 Do part 53 for l=1(1)3.
4.133 Delete part 53.
4.135 Recall item 16 (K9490).
4.14 Do part 54.
4.144 Delete part 54,part 55,part 58.
4.145 Recall item 17 (K9490).
4.15 Do part 56.
4.155 Delete part 56.
4.157 Recall item 18 (K9490).
4.16 Do part 57 for i=1(1)3.
4.166 Delete part 57.
4.168 Recall item 19 (K9490).
4.18 Do part 60.
4.19 Delete part 60,part 77,part 61,part 59.
4.195 Done if r=0.
4.20 To step 4.24 if N=0.
4.23 Discard item 2 (K9490).
4.24 File a,b,c,d,e as item 2 (K9490).
4.245 Set L=d(N,2).
4.25 Delete a,b,c,d,e.


Delete all.
Recall item  23 (K9490).
Done.
Type all.

9.10 Recall item 11 (K9490).
9.13 Do part 70.
9.14 Delete part 70, all forms.

13.10 Recall item 12 (K9490).
13.13 Do part 80.
13.14 Delete part 80, all forms.

14.10 Recall item 13 (K9490).
14.11 Do part 90.
14.12 Delete part 90, all forms.

15.10 Recall item 14 (K9490).
15.12 Do part 100.
15.13 Delete part 100, all forms.
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Delete all.
Recall item 24 (K9490).
Done.
Type all.

2.10 Recall item 1 (K9490).
2.11 Do part 10 for i=1(1)4.
2.12 Do part 11.
2.13 Do part 12.
2.14 Delete part 10, part 11, part 12.

6.10 Do step 6.11 for i=1(1)3.
6.11 Set M(i)=0.
6.12 Do step 6.13 for i=1(1)2.
6.13 Set X(i)=0.
6.14 Do step 6.15 for i=1(1)4.
6.15 Set Z(i)=0.
6.16 Do step 6.17 for i=1(1)2.
6.17 Set s(i)=0.
6.18 Do step 6.19 for i=1(1)3.
6.19 Set O(i)=0.

7.10 Do part 8 for j=1(1)8.
7.11 Do step 7.12 for i=1(1)11.
7.12 Set b(N,i)=0.
7.13 Do step 7.14 for i=1(1)8.
7.14 Set c(N,i)=0.
7.15 Do step 7.16 for i=1(1)4.
7.16 Set d(N,i)=0.
7.17 Do step 7.18 for i=1(1)9.
7.18 Set e(N,i)=0.

8.10 Do step 8.11 for k=1(1)6.
8.11 Set a(N,j,k)=0.
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Recall item 25 (K9490).
Done.
Type all.

30.01 Discard item 2 (K9490).
30.02 Set Q=0.
30.021 Line.
30.022 Line.
30.03 Demand P as "Do you want an introduction to this routine? Yes=1,No=2.".
30.04 To step 30.044 if P=2.
30.041 Recall item 21 (K9490).
30.042 Do part 5.
30.043 Delete part 5.
30.044 Line.
30.045 Line.
30.046 Type "Do you want to 'analyze' one program over time or".
30.047 Type "'compare' alternative programs for a given period?".
30.048 Demand R(20) as "Analyze=1, Compare=2.".
30.049 Line.
30.0491 Line.
30.05 Demand r as "Mode".
30.10 Set N=0.
30.11 Recall item 24 (K9490).
30.12 Do part 2.
30.13 Do part 6.
30.14 Do part 7.
30.15 Delete part 2,part 6,part 7,part 8.
30.155 Recall item 22 (K9490).
30.156 Do part 4.
30.157 Delete part 4.
30.16 Line.
30.164 Set s(2)=s(1).
30.165 Set s(1)=Q.
30.1655 Recall item 20 (K9490).
30.166 Do part 40 if r=1.
30.167 To step 30.17 if r=1.
30.168 Do part 41 if r=2.
30.169 To step 30.17 if r=2.
30.1695 Demand Q as "Action".
30.17 Delete part 40,part 41.
30.172 Recall item 6 (K9490).
30.175 Do part 22 if N=0 and Q=2.
30.177 Delete part 22.
30.178 Recall item 4 (K9490).
30.18 Do part 20 if Q=1.
30.184 Delete part 20.
30.185 Recall item 10 (K9490).
30.19 Do part 24 if Q=2.
30.195 Delete part 24.
30.20 Done if Q=5.
30.205 Recall item 22 (K9490).
30.21 Do part 4 if Q=3 and N>0.
30.22 Do part 4 if Q=4 and N>0 and s(1)≠3.
30.222 Recall item 6 (K9490).
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30.223 Do part 22 if Q=4.
30.225 Delete part 4,part 22.
30.226 Recall item 5 (K9490).
30.23 Do part 21 if Q=3.
30.24 Delete part 21.
30.25 To step 30.16.
```

REFERENCES

1. The Rand Corporation, *A Million Random Digits with 100,000 Normal Deviates*, The Free Press, Glencoe, Illinois, 1955.

2. Cronbach, L. J., and L. Furby, *How Should We Measure "Change"--Or Should We?*, Technical Report No. 6, Project on Individual Differences in Learning Ability as a Function of Instructional Variables, Stanford University Press, Palo Alto, California, 1969.

3. *Guidelines for Demonstration Programs in Reading and Mathematics*, State Department of Education, Sacramento, California, 28 October 1969, p. 28.

4. Tiegs, E., and W. Clark, *California Achievement Test Manual, Junior High Level*, California Test Bureau, Monterey, California, 1957, p. 8.

5. Hull, L. C., *Project R-3, AB-938 Demonstration, San Jose Unified School District*, Woodrow Wilson Junior High School, Spring 1970.

6. Levin, H. M., *A New Model of School Effectiveness*, Stanford University Center for Research and Development in Teaching, Palo Alto, California, Research and Development Memo No. 63, May 1970, p. 13.

7. *Memorandum CE/P 21-70*, State Board of Education, Sacramento, California, 29 October 1969.

8. Rapp, M. L., and E. M. Scheuer, *Evaluation of Project R-3*, The Rand Corporation, AR-402-SJS, August 1968.

9. Carpenter, M. B., and S. A. Haggart, *Analysis of Educational Programs Within a Program Budgeting System*, The Rand Corporation, P-4195, September 1969.

10. *Fiscal Review and Analysis of Selected Categorical Aid Education Programs in California*, Office of Legislative Analyst, Sacramento, California, 21 April 1970.

11. Carpenter, M. B., and S. A. Haggart, *Cost-Effectiveness Analysis for Educational Planning*, The Rand Corporation, P-4327, March 1970.